

Innovation for Sustainable Agricultural Growth in Cameroon



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SUGGESTED CITATION:

ZEF, FARA, IRAD (2017). *Country Dossier: Innovation for Sustainable Agricultural Growth in Cameroon*. Program of Accompanying Research for Agricultural Innovation. Bonn, Accra and Yaounde: Center for Development Research, Forum for Agricultural Research in Africa and Institut de Recherche Agricole pour le Développement.

ACKNOWLEDGEMENTS

The paper was developed within the project “Program of Accompanying Research for Agricultural Innovation” (PARI), which is funded by the German Federal Ministry of Economic Cooperation and Development (BMZ).

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

ACEFA	Programme d'Amélioration de la Compétitivité des Exploitations Agropastorales Familiales/ Program for the Improvement of Competitiveness of the Agro-pastoral Family Farms
AFD	Agence française de développement/ French Development Agency
AVRDC	World Vegetable Center
C2D	Contrat de désendettement et de développement/ French Debt Reduction and Development Contract
CAADP	Comprehensive Africa Agriculture Development Programme
CALs	cocoa agroforestry landscapes
CARBAP	Centre Africain de Recherches sur Bananiers et Plantains/ African Research Center on Bananas and Plantains
CDC	Cameroon Development Corporation
CEMAC	Communauté Economique et Monétaire de l'Afrique Centrale/ Central African Economic and Monetary Community
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement/ Center for International Cooperation in Agricultural Research for Development
CNOP-CAM	Concertation Nationale des Organisations Paysannes au Cameroun/ National consultation of farmer organizations in Cameroon
CORAF/WECARD	West and Central African Council for Agricultural Research and Development
CPAC	Comité des Pesticides d'Afrique Centrale/ Inter-State Pesticides Committee of Central Africa
CSIRO	Commonwealth Scientific and Industrial Research Organization
DHS	Demographic and Health Surveys
DONATA	Dissemination of New Agricultural Technologies in Africa
ECCAS	Economic Community of Central African States
EFA	Agricultural Family Farm
EU	European Union
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FSTP	Food Security Thematic Programme
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
GP	Producer groups
Hevecam	Hevea Cameroon
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
INNOBAP	Innovation variétale chez le bananier plantain/ Plantain and Banana Varietal Innovation Project
IRAD	Institut de Recherche Agricole pour le Développement/ Institute of Agricultural Research for Development
MINADER	Ministère de l'Agriculture et du Développement Rural/ Ministry of Agriculture and Rural Development
MINAGRI	Ministère de l'agriculture/ Ministry of Agriculture

NGO	Non-Governmental Organization
NTFPs	Non-timber forest products
OECD	Organization for Economic Co-operation and Development
OPAs	Professional Agricultural Organizations
PARI	Program of Accompanying Research for Agricultural Innovation
PIF	Plants Issus de Fragments de tige/ Plants Derived from Stem Fragments
PNVRA	Programme National de Vulgarisation et de Recherche Agricole/ National Agricultural Extension and Research Program
PPP	Purchasing Power Parity
R&D	Research and Development
RCA	Revealed comparative advantage
SEWOH	“One World, No Hunger” Initiative
SODECAO	Société de Développement du Cacao/ Development Corporation of Cocoa
SODECOTON	Société de Développement du Coton du Cameroun/ Cotton Company of Cameroon
SOWEDA	South West Development Authority
SUN	Scaling Up Nutrition
T&V	Training and Visit
TAV	Traditional African Vegetable
TFP	Total Factor Productivity
UCLA	University of California Los Angeles
UNICEF	United Nations International Children’s Emergency Fund
USA	United States of America
USDA	United States Department of Agriculture
WHO	World Health Organization
ZEF	Zentrum für Entwicklungsforschung/ Center for Development Research

1 General background information of the agricultural and food sectors

Cameroon is a country located in Central Africa with a total land area of 475,440 km² and a population of about 22 million inhabitants. It is bordered by Nigeria to the West, Chad to the Northeast, the Central African Republic to the East and Equatorial Guinea, Gabon, and the Republic of Congo to the South. Cameroon's coastline lies on the Bight of Bonny, which is part of the Gulf of Guinea and the Atlantic Ocean. Cameroon is sometimes described as "Africa in miniature," because it exhibits all the major climates and vegetation of the continent: mountains, desert, rain forest, savannah grassland, and ocean coastland. Cameroon can be divided into five agro-ecological zones (Table 1) distinguishable by dominant physical, climatic, and vegetative features. The climate varies with terrain, from tropical along the coast, to semi-arid and hot in the north. The coastal belt is hot and humid; it includes some of the wettest places on earth, such as Debundscha, located at the base of Mt. Cameroon, which has an average annual rainfall of about 10,287 mm.

Agriculture is the backbone of Cameroon's economy, employing 70% of its workforce and providing 44% of its gross domestic product and 30% of its export revenue. Cameroon produces several agricultural commodities for export and domestic consumption. The most important of these, which vary by agro-ecological zone (see Table 1), are cocoa, coffee, cotton, banana, rubber, palm oil, sugarcane, tobacco, tea, pineapple and peanuts for cash crops, and plantains, cassava, corn, millet, sorghum, yams, potatoes, sweet potatoes, dry beans, and rice for food crops. Animal husbandry is practiced throughout the country and is particularly important in the northern region.

Table 1: Major crops cultivated and animal species reared in each agro-ecological zone

Agro-ecological zones	Main crop and animal production
Sudano-Sahelian	Maize, millet-sorghum, rice, cowpea, soybean, onion, sesame, fruits, cotton, cattle and small ruminants
High Guinea Savanna	Maize, yam, cassava, sweet potatoes, rice, cotton, cattle, pig, small ruminants, poultry birds
Western Highlands	Maize, beans, potatoes, rice, sweet potatoes, vegetables, coffee, pig, poultry, cattle, small ruminants, fisheries
Mono-modal Humid Forest	Banana, plantain, cassava, cocoyam, sweet potatoes, maize, vegetables, cocoa, coffee, oil palm, rubber, fruits, poultry, pig, poultry birds, small ruminants, fisheries
Bimodal Humid Forest	Plantain, cassava, banana, maize, cocoyam, sweet potatoes, cocoa, oil palm, rubber, coffee, maize, cocoa, oil palm, fruits, poultry, pig, fisheries, small ruminants

Authors' compilation

In twelve African countries, including Cameroon, 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 Cameroon are chicken, onions, cocoa (and additionally, potato). The selection criteria considered the extent of effectiveness, implementation speed and accessibility to women and youth, market demand and potential, and the intersections with aid programs and other relevant actors.

1.1 Pan-African policies and strategies

Like most African countries whose economies greatly depend on the agricultural sector, Cameroon has established strategies and policies that align with those laid down by the African Union and other related organizations.

Even though the country signed the Comprehensive Africa Agriculture Development Programme (CAADP) on July 17th 2013, it has not yet met the CAADP 10% expenditure target, as its agricultural spending in 2013 only stood at 6.8%. Cameroon has also not been able to meet the CAADP annual increase of agricultural productivity by 6%. CAADP is Africa's policy framework for agricultural transformation, wealth creation, food security and nutrition, economic growth and prosperity for all. Cameroon joined the *Scaling Up Nutrition (SUN) Movement* in March 2013. SUN consists of 55 countries that have committed to scaling up nutrition and working collectively as a movement. The movement unites people — from governments, civil society, the United Nations, donors, businesses and researchers — in a collective effort to improve nutrition. Within the SUN Movement, governments are prioritizing efforts to address malnutrition. In addition, the country is a member of the **Africa Stockpiles Program**, which was initiated in 2000 by the Pesticide Action Network and the World Wide Fund for Nature, whose objective is to clean up stockpiles of obsolete pesticides (especially of persistent organochlorines). Cameroon is also a member of the *Bamako Convention* which bans the import into Africa and the control of trans-boundary movement and management of hazardous wastes within Africa. This was signed on the 1st of March 1991 and ratified on 11th of July, 1997.

Cameroon is a member of the Central African Economic and Monetary Community (CEMAC) and Economic Community of Central African States (ECCAS) that approved a *Common Agricultural Policy* for the region on 22-23 October 2014. ECCAS is an Economic Community of the African Union for the promotion of regional economic co-operation in Central Africa. The country is also a member of an important organization in the Central African Region – The Inter-State Pesticides Committee of Central Africa (CPAC). This organization was created in 11/03/2007 in Ndjamena, Chad, with the purpose to ensure that agricultural production (especially use of agrochemicals) does little or no harm to the environment and to human/animal health. The main objectives of the organization are:

- To carry out a common procedure for the registration of pesticides;
- To maintain the safety of food products;
- To recommend alternatives for extremely dangerous and dangerous pesticides;
- To analyze pesticides.

1.2 National (and regional) policies and strategies

In April 2014, Cameroon adopted a seven year (2014-2020) National Agricultural Investment Plan. The aim is to invest about FCFA 3.35 trillion into the development of agriculture in the country. The four priority areas for this investment plan are:

- (i) Development of the agricultural sectors (plants, livestock, fisheries and forestry);
- (ii) Modernization of production infrastructure in rural areas and improved mechanisms for access to finance;
- (iii) Management and sustainable use of natural resources; and
- (iv) Capacity building of stakeholders in rural development and the promotion of collaboration among these stakeholders.

Cameroon has a National Strategy for the Development of Rice Growing that seeks to improve the productivity and competitiveness of local rice by mitigating the constraints to production. The priorities and strategic directions include: (i) support for the acquisition of agricultural inputs, (ii) basic planning of irrigable areas and the rehabilitation of infrastructure and agricultural equipment in the large rice irrigation schemes, (iii) supporting producers with structuring and professionalization, and (iv) support for processing and marketing of rice.

Formulated for long-term development, the country's Vision 2035, "Cameroon: An emerging, democratic and united country in diversity" has the overall objective to make Cameroon an emerging country within the next generation (25-30 years). The Vision also has medium-term objectives, notably: (i) poverty alleviation, (ii) becoming a middle-income country, (iii) becoming a newly industrialized country, and (iv) consolidating democracy and national unity while respecting the country's diversity. The country's Vision 2035 is to be implemented in three phases: phase 1 (2010-2019), phase 2 (2020-2027), and phase 3 (2028-2035). The country is presently implementing phase 1, whose overall objective is to modernize the economy and accelerate growth and has the specific objectives of: (i) increasing Cameroon's overall economic productivity significantly so as to address urgent sector crises (food, energy, financial and employment, (ii) raising the investment rate significantly so as to attain two digit economic growth, (iii) lowering the poverty rate to less than 25%, and (iv) improving the business climate and public and corporate governance.

In addition, the government, in collaboration with many external/international research and funding agents, has been making significant efforts to improve agricultural productivity. The government is mitigating production constraints and wants to ensure food security by increasing the production of food stuff and other crops that could substitute imports. To meet these needs, the government has set a target in 2015 to train 30,000 farmers per year in 35 centers for agricultural training. In addition, the government has authorized the creation and operation of more private and government-supported institutes of higher learning to train more students in the field of crop production, crop protection, agro-economics, and food technology/processing. Since 2009, the government has developed an emergency plan, through the Ministry of Agriculture and Rural Development, to increase agricultural production by providing farmers with improved planting materials (for rice, plantain, maize, fruit trees, beans), increased pesticide and fertilizer subsidies from 20 to 50%, granted loans at low interest rates, created pools of agricultural machinery support of up to 15%, acquired hundreds of tractors and increased the capacity of processing, storage and packaging. The National Agricultural Extension and Research Program (PNVRA) provided technical and financial guidance to farmers through outreach activities.

1.3 Data on food and nutrition security in Cameroon and GIC region

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

Table 2: Selected national economic and health-related data

Indicator	Value	Year
Population, total	22,818,632	2014
Population growth (annual %)	2.5	2014
Rural population (% of total population)	46	2014
GDP per capita, PPP (constant 2011 international \$)	2,829	2014
GNI per capita, PPP (constant 2011 international \$)	2,803	2014
Poverty headcount ratio at \$2 a day (PPP) (% of population)	53	2007
Poverty headcount ratio at \$1.25 a day (PPP) (% of population)	28	2007
Poverty headcount ratio at national poverty lines (% of population)	40	2007
Rural poverty headcount ratio at national poverty lines (% of rural population)	55	2007
Agricultural land (% of land area)	21	2012
Agricultural irrigated land (% of total agricultural land)	no data	
Agriculture value added per worker (constant 2005 US\$)	1,264	2014
Agriculture, value added (% of GDP)	23	2014
Access to electricity, rural (% of rural population)	19	2012

Employees, agriculture, female (% of female employment)	58	2010
Employees, agriculture, male (% of male employment)	49	2010
Employment in agriculture (% of total employment)	53	2010
Literacy rate, adult total (% of people ages 15 and above)	71	2010
Ratio of female to male secondary enrolment (%)	86	2013
Mortality rate, under-5 (per 1,000 live births)	95	2013
Maternal mortality ratio (modelled estimate, per 100,000 live births)	590	2013

Source: World Bank, <https://data.worldbank.org/country>

Note: GDP refers to Gross Domestic Product; GNI refers to Gross National Income; PPP refers to Purchasing Power Parity

Table 3: Investment in Agriculture

Year	Percentage of total public investment dedicated to MINAGRI ¹
2003	0.07
2004	0.11
2005	0.07
2006	0.062
2007	0.044
2008	0.038
2009	0.043
2010	0.03
2011	0.063
2012	0.06

Source: Ministry of Agriculture (MINAGRI) (undated)

Table 4: Agricultural Gross Domestic Product (GDP)

Year	Agric (% of GDP)	GDP Growth (Annual %)
1995	23.6	4.1
1996	23.6	4.9
1997	24.7	5.3
1998	25.3	4.9
1999	24.4	4.1
2000	22.1	4.2
2001	22.2	4.5
2002	22.1	4
2003	21.7	4
2004	20.4	3.7
2005	20.6	2.3
2006	21	3.2
2007	22.9	3.3
2008	23.4	2.9
2009	23.5	1.9
2010	23.4	3.3
2011	23.6	4.1
2012	23.2	4.6
2013	22.9	5.6

Source: MINAGRI (undated)

¹ Ministry of Agriculture now MINADER

1.3.2 Consumption and nutrition status

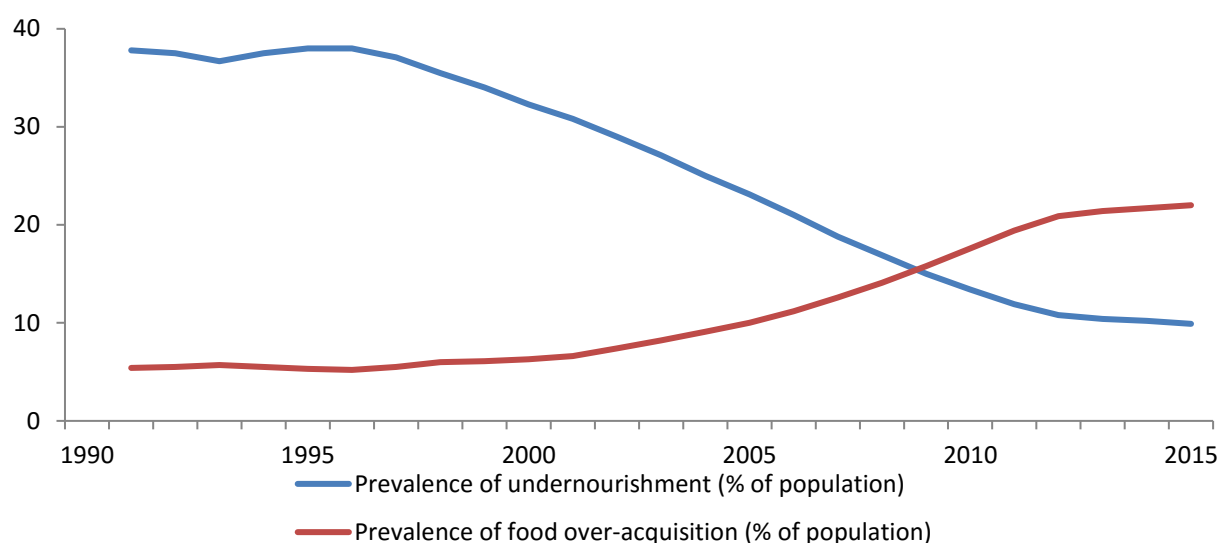
Data on diet quantity, diet quality and nutrition status are relevant for assessing food and nutrition security. Overall, dietary energy supply per capita – a measure of diet quantity – is sufficient in Cameroon, exceeding the average dietary energy requirement of the population by 18% (Table 5). One tenth of the population is unable to meet their minimum dietary energy requirements and suffers from chronic undernourishment. Cameroon has made good progress in reducing undernourishment since 1990-92, cutting the initial prevalence of 38% by almost three quarters (Figure 1). The prevalence of food-over acquisition has risen during the same period, but the increase of 17 percentage points was smaller than the concurrent decline in undernourishment. The Food and Agriculture Organization of the United Nations (FAO) estimates that a bit more than one fifth of Cameroon’s population regularly acquires food in excess of their dietary energy needs (Table 5).

Table 5: Food and nutrition security indicators

Indicator	Value	Year
<i>Diet quantity</i>		
Dietary energy supply (kcal/caput/day)	2625	2014-16
Average dietary energy supply adequacy (% of average requirement)	118	2014-16
Prevalence of undernourishment (% of population)	10	2014-16
Prevalence of food over-acquisition (% of population)	22	2014-16
<i>Diet quality</i>		
Dietary energy supply from cereals, roots and tubers (% of total dietary energy supply)	54	2009-11
Dietary energy supply from carbohydrate (% of total dietary energy supply)	70	2009-11
Dietary energy supply from protein (% of total dietary energy supply)	11	2009-11
Dietary energy supply from fat (% of total dietary energy supply)	20	2009-11
Average protein supply (g/caput/day)	68	2009-11
Average fat supply (g/caput/day)	55	2009-11
<i>Child feeding practices</i>		
Minimum dietary diversity: consumption of 4+ food groups (% of children 6-23 months)	34	2011
Consumption of foods rich in vitamin A (% of children 6-23 months)	73	2011
Consumption of foods rich in iron (% of children 6-23 months)	61	2011
<i>Nutrition status</i>		
Child wasting (% of children under five)	5	2014
Child stunting (% of children under five)	32	2014
Child overweight (% of children under five)	7	2014
Adult overweight and obesity (% of adults 18+ years)	34	2014
Adult obesity (% of adults 18+ years)	11	2014
Vitamin A deficiency (% of children 6-59 months)	45	2013
Anemia in children (% of children 6-59 months)	60	2011
Anemia in women (% of women 15-49 years)	40	2011

Source: FAO (2016), and authors’ calculations based on FAO (2016); Institut National de la Statistique and ICF International (2012); Institut National de la Statistique (2015); Stevens et al. (2015), quoted in International Food Policy Research Institute (IFPRI) (2015); World Health Organization (WHO) (2015a)

Note: See Annex A for definitions of the indicators.

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

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

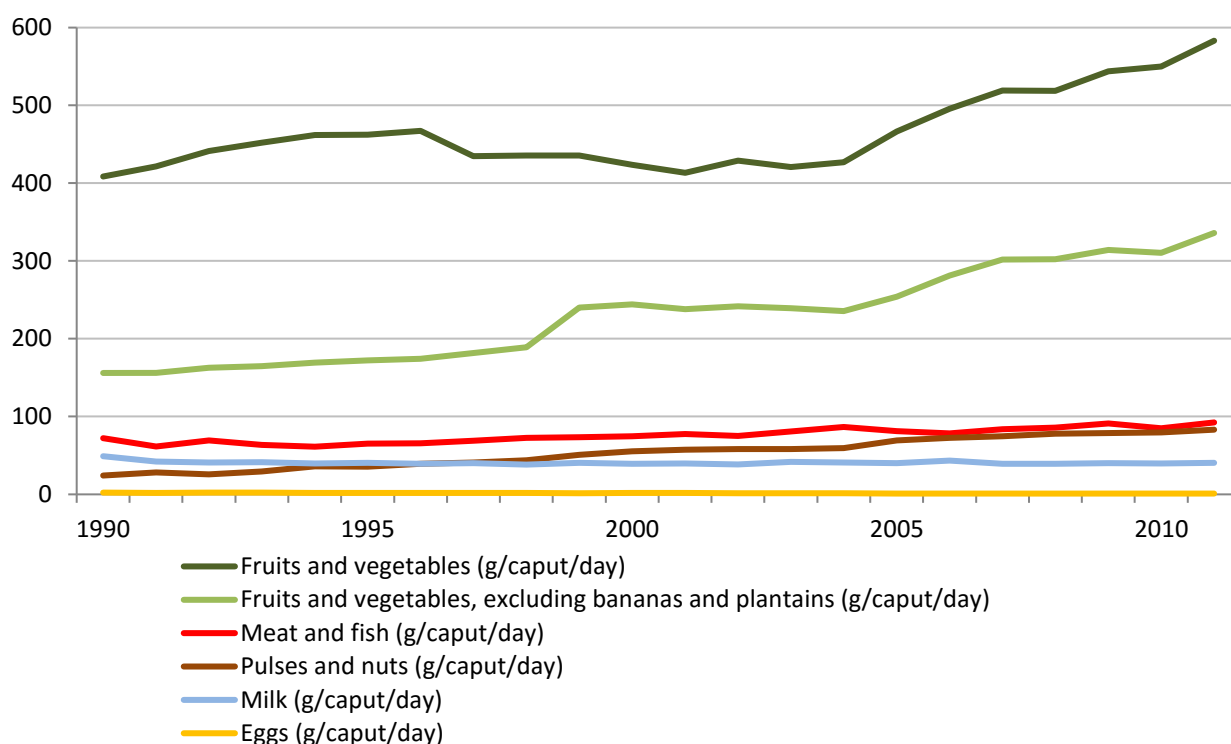
The main sources of dietary energy in Cameroon are cereals (especially maize, sorghum and rice) and starchy roots, mainly cassava. Since non-staple foods such as vegetable oils, fruits, pulses and nuts also play an important role in the Cameroonian diet, starchy staples contribute only a bit more than half of overall dietary energy supply (Table 5). The shares of dietary energy supply from carbohydrates, protein, and fat are within the recommended ranges of 55-75%, 10-15%, and 15-30%, respectively (WHO, 2003). This means that the diet is balanced in terms of its macronutrient composition. Average protein supply is more than adequate to meet protein requirements (Table 5; see Annex A for further explanation).

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 micronutrients. Meat and fish supply has increased in Cameroon since the early 1990s, but has not yet reached 100 g/caput/day (Figure 2). Since 1990, the milk supply has remained virtually constant at a low level of 40 g/caput/day, and eggs play only a very minor role in the Cameroonian diet. The supply of pulses and nuts has grown markedly in past decades and amounts to more than 80 g/caput/day; pulses and nuts provide roughly one fourth of protein supply in Cameroon.² The supply of fruits and vegetables approached an impressive 600 g/caput/day by 2011, considerably above the recommended intake of 400 g of fruits and vegetables per day (WHO 2003). Plantains and bananas make up more than two fifths of total fruit and vegetable supply, but the growth in the supply of this food group is attributable to increases in the supply of vegetables (Figure 2).³ African eggplant, okra and the green leafy vegetables amaranth, nightshade, and jute mallow are popular indigenous nutritious (Chagomoka et al., 2014).

² Source: Food balance sheet for Cameroon, 2011, from FAOSTAT, accessed 19 November, 2016.

³ Bananas and plantains are rich in carbohydrate and B-vitamins, and plantains are also a good source of vitamins A and C, but these fruits have lower concentrations of micronutrients than dark green leafy vegetables, for example (United States Department of Agriculture (USDA) 2016).

Figure 2: Supply of non-staple foods (1990-2011)

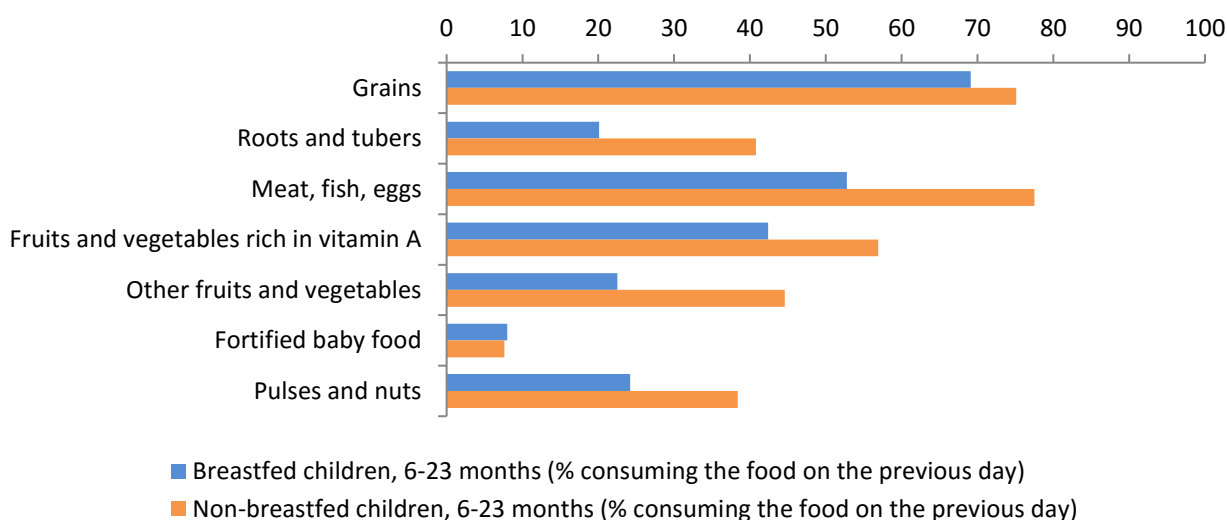


Source: Authors' presentation based on data from FAOSTAT, accessed 07 October, 2016

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.

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 Cameroon, infants' and young children's diets fall short of these goals: roughly one third achieved minimum dietary diversity, almost three quarters consumed foods rich in Vitamin A, and 61% had foods rich in iron on the previous day (Table 5). Breastfed children aged 6-23 months were most frequently fed foods made from grains, and non-breastfed children were fed foods made from grains as well as meat, fish and eggs (Figure 3). Other micronutrient-rich foods such as fruits and vegetables that are rich in vitamin A, other fruits and vegetables, and pulses and nuts, were given more rarely to both breastfed and non-breastfed children, and only about half of breastfed children consumed meat, fish and eggs on the previous day. Fortified baby foods, which can compensate for a lack of micronutrients in the diet, were consumed by less than 10% of breastfed and non-breastfed children.

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



Source: Authors' presentation based on data from the Institut National de la Statistique and ICF International (2012)

Stunting and wasting are indicators of chronic and acute child undernutrition, respectively. In Cameroon, about one third of children under five are stunted and 5% are wasted, indicating that stunting is a moderate health problem and wasting a mild public health problem (Table 5). There has been very little progress in reducing child undernutrition since the early 1990s: The proportion of stunted children fell by only 5 percentage points, and according to the latest data, the prevalence of wasting is at virtually the same level as in 1991 (UNICEF/WHO/World Bank, 2016)⁴. With a prevalence of 7%, overweight among children has moderate public health significance (Table 5).

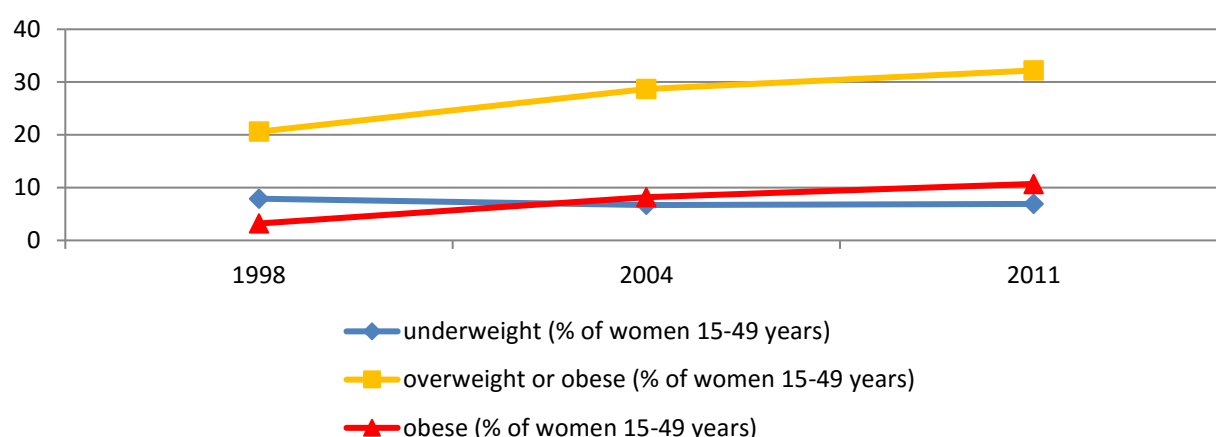
Overweight and obesity are risk factors for chronic diseases such as diabetes (Must and McKeown 2012). About one third of adults in Cameroon are overweight or obese (Table 5). According to data from the Demographic and Health Surveys (DHS), the combined prevalence of overweight and obesity among women of reproductive age has increased by more than 50% since the late 1990s, while the prevalence of obesity has more than tripled during the same period (Figure 4). The prevalence of underweight has fallen slightly and is relatively low at the national level, amounting to 7%.⁵

Vitamin A deficiency is a risk factor for blindness and for mortality from measles and diarrhoea in children aged 6–59 months (Imdad et al. 2010; Imdad et al. 2011). In Cameroon, 45% of all children in this age group are estimated to be vitamin A deficient (Table 5). Two fifths of women of reproductive age and three fifths of children aged 6–59 months suffer from anemia (Table 5). About half of the global burden of anemia can be attributed to iron deficiency (WHO, 2015b). Anemia is also caused by malaria, which is widespread not only in West Africa, but also in Cameroon and in some other Central African countries (University of Oxford, 2015).

⁴ United Nations International Children's Emergency Fund (UNICEF)

⁵ See Annex A for definitions of overweight, obesity, and underweight.

Figure 4: Underweight, overweight and obesity among women of reproductive age (1998-2011)



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

Regionally disaggregated data are available for indicators of nutrition status and child feeding. The diversity of infants' and young children's diets is particularly low in the Nord and Extrême-Nord regions, and these two northernmost regions also rank worst on the shares of children consuming foods rich in vitamin A and iron (Table 6). The city of Douala and the Sud Ouest region have the highest proportions of children who achieved minimum dietary diversity (4+ food groups on the previous day) and who consumed foods rich in iron, and the Sud Ouest and Centre regions do best on the share of children consuming foods rich in vitamin A. In the Ouest region and the capital city Yaoundé, children have the lowest rates of anemia, whereas anemia prevalence is highest in the Sud and Sud Ouest regions (Table 7). The Nord, Extrême-Nord and Adamaoua regions have the highest stunting rates, more than three times as high as in the cities of Yaoundé and Douala. Wasting is also elevated in the Nord and Extrême-Nord regions.

Table 6: 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	(%)
Douala	57	Sud Ouest	84	Sud Ouest	76
Sud Ouest	54	Centre	82	Douala	76
Yaoundé	50	Ouest	82	Ouest	75
Ouest	48	Nord Ouest	80	Yaoundé	72
Centre	38	Adamaoua	80	Sud	68
Nord Ouest	36	Douala	79	Adamaoua	67
Sud	36	Sud	79	Centre	66
Adamaoua	36	Yaoundé	77	Est	62
Littoral	30	Est	77	Littoral	60
Est	30	Littoral	72	Nord Ouest	54
Nord	19	Nord	67	Nord	54
Extrême-Nord	14	Extrême-Nord	59	Extrême-Nord	45

Source: Institut National de la Statistique and ICF International (2012)

Notes: GIC regions are highlighted in red. The capital Yaoundé is situated in the Centre region, and the city of Douala in the Littoral region, but the data are shown separately for these two cities, the Centre region (not including Yaoundé), and the Littoral region (not including Douala). See Annex A for definitions of the indicators.

Overweight and obesity rates in women are highest in the large urban centers, namely in Yaoundé and Douala, and lowest in the two northernmost regions (Table 8). Rates of underweight in women is highest in the Extrême-Nord, Adamaoua, and Nord regions. Women in the Ouest and Nord Ouest regions are least affected by anemia, while anemia rates are highest in the Sud and Sud Ouest regions and in Douala.

Table 7: Child nutrition status by region, 2011

Prevalence among children under five:						Prevalence among children 6-59 months:	
Stunting		Wasting		Overweight		Anemia	
Region	(%)	Region	(%)	Region	(%)	Region	(%)
Yaoundé	13	Ouest	1	Nord	2	Ouest	46
Douala	13	Littoral	1	Extrême-Nord	2	Yaoundé	47
Centre	23	Nord Ouest	2	Sud Ouest	5	Nord Ouest	52
Littoral	24	Yaoundé	2	Sud	5	Littoral	57
Sud Ouest	27	Douala	3	Centre	5	Adamaoua	62
Ouest	32	Sud Ouest	3	Adamaoua	6	Douala	63
Sud	33	Centre	4	Est	6	Extrême-Nord	64
Nord Ouest	36	Sud	5	Yaoundé	8	Centre	66
Est	37	Est	6	Douala	9	Est	67
Adamaoua	40	Adamaoua	6	Ouest	11	Nord	68
Nord	40	Nord	10	Littoral	11	Sud Ouest	70
Extrême-Nord	45	Extrême-Nord	12	Nord Ouest	11	Sud	74

Source: Institut National de la Statistique and ICF International (2012)

Notes: GIC regions are highlighted in red. The capital Yaoundé is situated in the Centre region, and the city of Douala in the Littoral region, but the data are shown separately for these two cities, the Centre region (not including Yaoundé), and the Littoral region (not including Douala). See Annex A for definitions of the indicators.

Table 8: Women's nutrition status by region, 2011

Prevalence among women of reproductive age (15-49 years):							
Underweight		Overweight + obesity		Obesity		Anemia	
Region	(%)	Region	(%)	Region	(%)	Region	(%)
Ouest	2	Extrême-Nord	7	Extrême-Nord	1	Ouest	23
Littoral	2	Nord	17	Nord	5	Nord Ouest	30
Nord Ouest	3	Adamaoua	22	Centre	8	Yaoundé	36
Yaoundé	3	Centre	27	Adamaoua	8	Adamaoua	36
Douala	3	Est	28	Sud	8	Extrême-Nord	37
Sud Ouest	3	Sud	28	Est	8	Littoral	38
Centre	4	Nord Ouest	35	Nord Ouest	9	Nord	41
Sud	7	Littoral	43	Sud Ouest	13	Est	44
Est	11	Sud Ouest	43	Ouest	14	Centre	48
Nord	11	Ouest	45	Littoral	14	Sud	53
Adamaoua	17	Yaoundé	46	Yaoundé	17	Douala	53
Extrême-Nord	17	Douala	46	Douala	22	Sud Ouest	54

Source: Institut National de la Statistique and ICF International (2012)

Notes: GIC regions are highlighted in red. The capital Yaoundé is situated in the Centre region, and the city of Douala in the Littoral region, but the data are shown separately for these two cities, the Centre region (not including Yaoundé), and the Littoral region (not including Douala). See Annex A for definitions of the indicators.

Of all indicators of children's nutrition status that are available at the regional level, anemia has the highest rates, followed by stunting (Table 7). Assuming that half of all anemia is due to iron deficiency, iron deficiency anemia in children has moderate public health significance in all regions.⁶ Stunting is a severe public health problem in the Nord and Extrême-Nord regions, a moderate problem in the Adamaoua, Est, Nord Ouest, Sud and Ouest regions, and a mild problem in the Sud Ouest, Littoral, and Centre regions. Wasting is a moderate health problem in the Nord and Extrême-Nord regions, and mild in the Adamaoua, Est, and Sud regions. Overweight in children is a severe public health concern in the Nord Ouest, Littoral, and Ouest regions, a mild concern in the Sud and Sud Ouest regions, and a moderate concern in all other regions except for the Nord and Extrême-Nord regions, where the prevalence is only 2% and is therefore below the threshold for public health significance.

Out of all indicators of women's nutrition status that are available at the regional level, anemia has the highest rates in 8 out of 12 regions, and the combined prevalence of overweight and obesity is highest in the remaining 4 regions, namely in Yaoundé and the Littoral, Ouest and Nord Ouest regions (Table 8). The Extrême-Nord region is the only region where underweight rates in women surpasses overweight and obesity rates, since 17% of women are underweight, but only 7% are overweight or obese.

In summary, Cameroon faces problems of both over- and undernutrition, and micronutrient deficiencies are widespread. Dietary energy supply should be increased in disadvantaged regions, ideally without spurring further increases in overweight and obesity in the urban centers and better-off regions. The supply of micronutrient-rich foods needs to be increased to combat micronutrient deficiencies. Priority should be given to developing value chains for vegetables, fruits, animal-source foods, pulses and nuts, and possibly also to the value chain for red palm oil (rich in vitamin A). Fruits and vegetables already play a significant role in the Cameroonian diet, and pulses and nuts are important sources of protein and micronutrients, but the supply of animal-source foods is fairly 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 iron-rich beans and vitamin A-rich orange-fleshed sweet potatoes, yellow cassava and orange maize developed by HarvestPlus, also has the potential to improve micronutrient intakes.⁷

In addition, reducing the aflatoxin contamination of foods is necessary to improve food safety in Cameroon. 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). An analysis of maize, groundnuts, and cassava from Cameroon concluded that about half of the samples were contaminated with aflatoxins or other mycotoxins such as fumonisins. The mycotoxins occurred most frequently in maize and least frequently in cassava (Ediage et al., 2014). Aflatoxins were also found in soybeans, groundnut soup, maize beer; groundnuts and groundnut products were found to have the highest concentrations (Abia et al., 2013). Poultry feed from three agro-ecological zones in Cameroon tested positive for aflatoxins, and groundnut meal was the most contaminated type of feed (Kana et al., 2013). Aflatoxins in animal feed impair the productivity of livestock and are transferred to milk and eggs; Aflatoxins were detected in 45% of egg samples and in 16% of milk samples collected in 1991-95 from various climatic regions in Cameroon (Tchana et al., 2010).

⁶ About half of the global burden of anemia is attributable to iron deficiency (WHO, 2015b). Since the rates of anemia in children in Cameroon is in the range of 46-74% at the regional level, the rate of iron deficiency anemia can be estimated to be 23-37%, falling within the range of 20-39%, which has been defined as indicating a moderate public health problem (see Annex A). However, it is possible that less than half of all anemia in Cameroon is caused by iron deficiency because malaria is endemic in the country.

⁷ See <http://www.harvestplus.org/what-we-do/crops>.

A look at the regions reveals that nutritional deficiencies are most severe in the Nord and Extrême-Nord regions. This suggests prioritizing the two northernmost regions for interventions and agricultural innovations. Nevertheless, climatic and other factors may limit the agricultural potential of these areas. In the urban centers of Yaoundé and Douala and in the Ouest, Sud Ouest and Littoral regions, overnutrition has emerged as a significant problem, with more than 40% of women being overweight or obese. Cameroon is a member of the SUN network, a global movement led by 57 countries that aims to end malnutrition in all its forms. See scalingupnutrition.org/ for more information.

1.4 Data on most relevant crops and value chains

The most relevant food crops in Cameroon include maize, rice, sorghum, tubers (mainly cassava, yams and taro), fruits, groundnuts, bananas and plantains, coffee, cocoa and oil palm. Production and consumption data are provided below.

1.4.1 Production

Cassava ranks high(est), notably in terms of its share volume and value of production (Table 9). Other important crops by cultivation area are maize, sorghum, cocoa beans and groundnuts. Plantains, maize, groundnuts and Taro have the highest production value. Meat from indigenous cattle constitutes over 44% of total meat production, followed by chicken meat with almost 28% (Table 10).

Table 9: 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 (%)
Maize	14.1	Cassava	18.3	Cassava	16.1
Sorghum	12.7	Plantains	14.8	Plantains	13.8
Cocoa, beans	10.7	Oil, palm fruit	10.0	Maize	8.5
Groundnuts	7.0	Maize	6.6	Cocoa, beans	7.9
Cassava	5.4	Taro (cocoyam)	6.4	Taro (cocoyam)	7.8
Plantains	5.0	Bananas	6.4	Groundnuts	6.2
Beans, dry	4.0	Sugar cane	4.8	Tomatoes	5.3
Cucumbers & gherkins	3.3	Sorghum	4.8	Sorghum	4.6
Seed cotton	3.2	Tomatoes	3.5	Oil, palm	3.8
Cow peas, dry	3.0	Vegetables, fresh nes	3.0	Beans, dry	3.7
Rank 35: Onions, dry	0.1	Rank 15: Cocoa, beans	1.1	Rank 12: Meat, chicken	2.9
		Rank 20: Onions, dry	0.8	Rank 13: Meat indigenous, chicken	2.9
				Rank 22: Onions, dry	0.8

* Gross Production Value (constant 2004-2006 million US\$), data: average 2011-2013, FAOSTAT, accessed 17 January, 2017

Note: GIC value chains are marked in red; nes refers to: Not elsewhere specified

Data: average 2012-2014, FAOSTAT, accessed 17 January, 2017

Table 10: Meat production (tons)

Commodity	Share of total meat (%)
Meat indigenous, cattle	44.2
Meat indigenous, chicken	27.9
Meat indigenous, pig	12.8
Meat indigenous, goat	8.1
Meat indigenous, sheep	6.8
Meat indigenous, horse	0.1
Meat indigenous, rabbit	0.0

Note: GIC value chains are marked in red

Data: average 2011-2013, FAOSTAT, accessed 17 January, 2017

1.4.2 Trade

Cameroon is considered one of the most important market in the CEMAC zone, accounting for nearly 50% of GDP. Millet, sorghum, rice, yam, cassava, fruits (e.g. pineapple, papaya, and oranges), fresh vegetables and plantain are produced for both domestic consumption and for exports to countries within the central African region. The main cash crops, which provide 86.5% and 84.2% of total export volume and value respectively, are bananas, cocoa (the country is the world 5th largest producer), cotton, coffee and natural rubber (Table 11). The top agricultural imports are rice, wheat, malt and refined sugar, which account for over 78% and 57% of total volume and value respectively (Table 12).

Table 11: Top 10 agricultural products exported

Export volume (tons)		Export value (US\$)	
Top 10	Share of Total (%)	Top 10	Share of Total (%)
Bananas	37.2	Cocoa, beans	41.8
Cocoa, beans	27.9	Cotton lint	13.3
Cotton lint	11.2	Bananas	12.0
Rubber natural dry	5.1	Rubber natural dry	10.2
Coffee, green	5.1	Coffee, green	6.9
Cocoa, butter	1.3	Cocoa, butter	2.9
Pineapples	1.2	Cocoa, paste	2.3
Cocoa, paste	1.1	Cocoa, powder & cake	1.7
Rubber, natural	1.1	Rubber, natural	1.7
Food prep nes	1.0	Food prep nes	1.5
Rank 136: Onions, dry	0.0	Rank 125: Onions, dry	0.0

Note: GIC value chains marked in red; nes refers to: Not elsewhere specified

Data: average 2011-2013, FAOSTAT, accessed 17 January, 2017

Table 12: Top 10 agricultural products imported

Import volume (tons)		Import value (US\$)	
Top 10	Share of Total (%)	Top 10	Share of Total (%)
Rice – total (Rice milled equiv.)	38.2	Rice – total (Rice milled equiv.)	29.8
Wheat	30.2	Wheat	17.2
Sugar refined	5.0	Sugar refined	5.2
Malt	4.9	Malt	5.2
Oil, palm	3.1	Oil, palm	4.7
Cake, soybeans	2.5	Food prep nes	4.0
Macaroni	1.1	Milk, whole dried	3.9
Flour, maize	1.1	Cigarettes	2.6
Food prep nes	1.1	Infant food	2.2
Sugar raw centrifugal	1.0	Cake, soybeans	1.9
Rank 25: Onions, dry	0.3	Rank 44: Onions, dry	0.2
		Rank 63: Meat, chicken	0.1

Note: GIC value chains marked in red; nes refers to: Not elsewhere specified

Data: average 2011-2013, FAOSTAT, accessed 17 January, 2017

The other GIC value chains (Chicken, Onion, Irish potato) are not significant in terms of trade.

Generally, the European Union (EU), China, Nigeria, and the United States of America (USA) are Cameroon's biggest trading partners. Cameroon's total trade share to the EU is 0.1% and half of the country's total export is to the EU, with France as the main trading partner and source of private investment and foreign aid. The USA has investments worth US Dollars 1 million in Cameroon, however, this is mainly in the oil sector.

Table 13: Total Goods: Top trading partners 2013

Imports				Exports			
No	Partner	Value (million €)	Share in World (%)	No	Partner	Value (million €)	Share in World (%)
	World	5,520	100		World	4,228	100
1	EU 28	1,883	34.1	1	EU 28	2,196	51.9
2	China	1,276	23.1	2	USA	256	6.1
3	Nigeria	593	10.8	3	China	255	6.0
4	USA	282	5.1	4	India	208	4.9
5	India	243	4.4	5	Chad	181	4.3
6	Thailand	132	2.4	6	Gabon	170	4.0
7	Brazil	89	1.6	7	Trinidad and Tobago	120	2.8
8	Turkey	86	1.6	8	Ghana	90	2.1
9	Ivory Coast	81	1.5	9	Norway	76	1.8
10	South Africa	58	1.1	10	Nigeria	66	1.6

Source: EuroStat IMF (undated). World trade excluding inter-region trade and top partners excluding region member states

1.5 National (and regional) innovation system

1.5.1 Research system and organizations

Agricultural research in Cameroon is conducted by a number of national and international institutions organizations, and universities. These entities are engaged in various fields of research pertaining to the different agricultural sectors in the country.

1.5.1.1 International

A number of international research institutions have country offices and research stations in Cameroon e.g.

- International Institute of Tropical Agriculture (IITA): cassava, banana, plantain, maize, cocoa, entomology and social studies;
- The World Vegetable Center (AVRDC): vegetables;
- The Center for International Cooperation in Agricultural Research for Development, CIRAD: food security, agroforestry systems, agro-industrial plantations, aquaculture systems and cotton cropping systems;
- World Agroforestry Centre: agroforestry systems;
- Biodiversity International: agricultural and tree biodiversity;
- Center for International Forestry Research: forest management, gender, climate change, food and biodiversity, forest policy, products and trade, and landscape;
- University of California, Los Angeles International Research and Training Center in Cameroon: conservation, ecology and evolution, infectious diseases, and biodiversity;
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (Cameroon-German partnership). The GIZ is a major funder of agriculture and environment activities in the country;
- Forum for Agricultural Research in Africa (FARA) which, through other organizations like IITA and AVRDC, has been putting efforts to set up innovation platforms and support their activities;
- The African Research Center on Bananas and Plantains (CARBAP) has been playing an important role by carrying out research on bananas and plantains
- World Wide Fund for Nature

1.5.1.2 National

The public agricultural research organization is the Institute of Agricultural Research for Development (IRAD), which was established in 1996 to conduct agricultural research with a mandate to focus on annual and perennial crops, livestock and fisheries, forest and environment, farming systems, economics and rural sociology. IRAD works in collaboration with many local and international research institutions and development partners. Some government and private universities are also involved in agricultural research in Cameroon. These include: University of Dschang, University of Ngaoundere, University of Yaounde I, University of Buea, University of Bamenda, Catholic University of Cameroon, Cameroon Christian University, and Catholic University Institute of Buea.

1.5.2 Innovation platforms

According to FARA, an innovation platform is a physical or virtual forum established to facilitate interactions and learning among stakeholders selected from a commodity chain, leading to a participatory approach to diagnosing problems, joint exploration of opportunities and investigation of solutions. The aim of innovation platforms is to promote agricultural innovation along the targeted commodity chain. Innovation in agriculture is the process of ensuring that a new product or knowledge is converted to perpetual use. One of the important and emerging ways to implement the innovation systems approach for agricultural development is via the Integrated Agricultural Research for Development concept developed by FARA. Innovation platforms are widely used in agricultural research projects in Cameroon (see Table 14 for a few examples).

Table 14: Some agricultural innovation platforms set up in Cameroon

Location	Project/Purpose	Commodity Value Chain
Adamawa Region (Ngaoundere and Guider)	Sustainable Intensification of Integrated Agricultural Farming Systems. Funded by AusAid and implemented by IRAD/CSIRO/CORAF (2013) ⁸ Purpose was to increase agro-pastoral productivity and food security in West and Central Africa.	Fresh milk and Meat
Center, East, South & Littoral Regions (Nkong-Abok, Batchenga, Okola, Ngat, Gouekong, Lobo, Banyo, Mefomo, Kiki, Pouma)	Dissemination of New Agricultural Technologies in Africa (DONATA) (2007 to 2014) Funded by the African Development Bank via FARA and implemented by IRAD Focus in Cameroon was on production, processing and marketing	Cassava
South & Littoral Regions (Ambam and Kombe)	Plantain and banana varietal innovation project (INNOBAP) Funded by European Commission and implemented by Bioversity/CARBAP Regional Network of Multi-stakeholders Platforms for Participatory Improvement of Banana & Plantain Varieties	Plantain and Banana
South (Ntem)	Food Security Thematic Programme (FSTP) Project Funded by the European Commission and implemented by CARBAP/CIRAD Implemented for the improvement of food security and living standards of the poor via development of banana and plantain sector in Central Africa.	Banana and Plantain
North, Extreme North, West and North West	New Rice for Africa (NERICA) Rice Project Funded by Common Funds for Commodities via Africa Rice To enhance competitiveness of rice in Central Africa and to improve food security, rural income as well as to reduce the importation of rice.	NERICA Rice
Western Highlands (Kouoptamo community)	Funded by International Livestock Research Institute Implemented by IRAD For purpose of Harnessing Genetic Diversity for Improved Goat Productivity	Goat
West and SouthWest Regions (Bansoa & Ekona)	Funded by CORAF/WECARD Implemented by CARBAP Promote integrated management technologies for the cultivation of plantains to improve farm productivity	Plantain

Source: Okolle *et al.* (2016)

⁸ Institute of Agricultural Research for Development/ Commonwealth Scientific and Industrial Research Organization/ West and Central African Council for Agricultural Research and Development

1.5.3 Extension system and organizations

Agricultural extension proper began in the 1970s when the government increased its intervention in agriculture by establishing as many as 24 parastatal development agencies. After prices of export crops fell worldwide in 1986, leading to low incomes for farmers and food shortages in Cameroon beginning in 1988, the World Bank financed the National Agricultural and Education Program. The focus of this support was on the Training and Visit (T&V) extension system comprising three main components: extension, training, and information. Because the T&V system was not very effective, the government launched the PNVRA. The major institutions providing extension/advisory services are as follows:

1.5.3.1 Public Institutions

- The Ministry of Agriculture and Rural Development in Cameroon (MINADER) has a number of agricultural extension-related functions. These include: disseminating information and advice to farmers; checking agricultural and cooperative education; supervising private agricultural education in conjunction with the Ministry of Vocational Training; and managing farmers and agricultural extension;
- The National Program for Agricultural Extension and Research (PNVRA), operating with MINADER, is the main public agency for providing extension services to farmers in Cameroon. It had about 1,651 extension staff in 2009. This agency carries out the following activities: agricultural extension, training and development of human resources, support to producer organizations and associations, partnership with the private sector, agricultural research, village community participatory pilot development operations, and monitoring and evaluation as well as impact assessment of the extension program;
- Chamber of Agriculture, Fishery, Livestock and Forest: Its main role is to defend the interests of producers in the Agricultural, Fishery, Livestock and Forestry sectors, develop partnerships with investors and facilitate the training of farmers;
- Institute of Agricultural Research for Development (IRAD): From time to time and/or in collaboration of MINADER, IRAD trains farmers on best practices for cultivation of certain crops or rearing of certain livestock;
- The Société de Développement du Coton du Cameroun (SODECOTON) is a semi-autonomous public organization that also provides extension services in cotton production in northern Cameroon. In 2009, it had about 306 extension staff;
- Southwest Development Authority (SOWEDA): This organization is funded by the government and other foreign agents. Its key role is to help the small-scale farmers in the Southwest Region through training and providing improved seeds and information in collaboration with MINADER and IRAD;
- North West Development Authority Project caters to the Northwest Region, and its mission is to help strengthen extension services to female producers. The method of extension used were mainly individual and group contacts and provision of farm inputs ([www. g-fras.org](http://www.g-fras.org)).

1.5.3.2 Private sector

There is no established private company or Non-governmental organization (NGO) that provides extension and advisory services to the farmers on regular basis. However, some of the NGOs (e.g. Institut Africain pour le Développement Economic et Social-Formation) are active in extension-type activities. There are also many agrochemical companies that train farmers and other stakeholders on pesticide safety measures, although the service rendered may be irregular. These companies include Agrochem, Fimex, Syngenta, DuPont, etc. In addition to these, some service such as AgroVital Services & Consulting (AgroViSc) carry out research and sensitize the public on pest and pesticide management using different media e.g. print, TV and Radio.

Program of Accompanying Research for Agricultural Innovation (PARI)

A number of farmer-based associations or cooperatives provide extension and market advisory services to their members. Some of these associations are:

- Associations de Producteurs et de Stockeurs de Cereales;
- South West Farmers Association, Ltd.;
- South West Federation of Plantain Farmers;
- Cameroon Federal Farmers Association;
- Northwest Cooperative Association Limited;
- Wum Honey Farmers Association;
- Cameroon Cooperative Credit Union League;
- The National Consultation of Farmer Organizations in Cameroon, CNOP-CAM, and Plate-forme nationale des organisations professionnelles agro-sylvo-pastorales du Cameroun (national platform of professional agro-pastoral organizations of Cameroon).

1.5.4 Private research and development activities

Some of the private sector companies involved in the supply of agricultural inputs, and in the trading, export, and import of agricultural commodities in Cameroon are presented below. Some of them are international companies but have offices or agents in Cameroon. Besides import and export of agricultural inputs, these companies collaborate with some research institutes to carry out research.

- Cameroon Agric Complex Inc. (located in Littoral manufactures and supplies cooking oils, seeds, chemicals and animal feed);
- Glochem Industries Ltd. (located in Littoral; deals in pesticides, fungicides, insecticides and algaecides);
- Cameroon Chemical Fertilizer Production Company Ltd. (located in Muyuka, South West Region; produces chemical fertilizers, like urea and Diammonium phosphate);
- Nlaten Farms, Ltd. (established in 2008; trades in agriculture, food and beverages and chemicals);
- Agriculture and Pet Products (established in 2010; exports fresh eggs and egg products);
- Mohamedou adventures, Ltd. (established in 2001; exports agricultural inputs and outputs);
- Lipenja Development Corporation (established in 2010; deals in palm oil, sunflower oil, and olive oil);
- Development Action Group (Groupe d'Action pour le Développement). It is a private company involved in some extension work, and had about 46 extension staff in 2009.

Some agrochemical companies (Jako, Syngenta, Agrochem, Arysta Life Sciences, DuPont and Senachem, etc.) fund research specifically on the bioefficacy of pesticides and effects of fertilizers, with a large focus on export crops such as bananas, cotton, oil palm, rubber, cocoa, as well as other important crops for domestic consumption such as maize, yams, cassava, and vegetables. In all cases, these companies fund research and collaborate with public and/or private research institutions such as IRAD, Faculties of Agriculture/Agronomy of universities, and AgroVital Services & Consulting (AgroViSc). Additionally, MINADER and CPAC collaborate on research with large plantations (e.g. SODECOTON) for the purpose of registering chemicals for some main export crops.

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

Key challenges to the development of the agricultural sector in Cameroon include:

- Production shortages in all major crops (rice, cassava, plantains, corn, potato and sugar cane);
- Low productivity of the smallholder farming systems;
- Poor methods for the conservation and marketing of fresh vegetables;

- Difficulty in accessing farm inputs (fertilizers and pesticides);
- Lack of or insufficient improved seeds;
- Weak organization by producers;
- High post-harvest losses;
- Dilapidated or low output husking equipment in the rice sector;
- Poor funding of agricultural research activities;
- High dependency on imported rice;
- Limited access to credit/rural finance;
- Poor value chain development for most commodities;
- Very limited mechanization;
- Inadequate farm-to-market roads (especially in high crop production areas), most of which are in a very bad state.

1.7 Potential areas for investment in Cameroon

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

- Show actual progress in sustainable agricultural productivity, driven by 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 Cameroon⁹

Expected agricultural growth performance:

- Cameroon has increased its agricultural growth to over 6% (CAADP target) in only one year between 2005 and 2014 (www.resakss.org).
- Total agricultural factor productivity in Cameroon has improved by only 7% between 2001 and 2008 (Fuglie and Rada, 2011), indicating that Cameroon's commitment to research and development in the agricultural and food sector is not sufficient.

Government commitment:

- Cameroon does not have a good track record of political commitment to foster sustainable agricultural growth, as indicated by its low level of activity in the CAADP process and having completed only two out of the eight steps in the CAADP process (www.resakss.org).
- Cameroon has not shown a strong willingness to invest in the agricultural sector. In no single year has the country invested more than 10% of total government expenditures (CAADP target) in agriculture in the 2005-2014 period (www.resakss.org).

Food and nutrition security progress and need:

- Cameroon is prioritizing actions for the reduction of hunger and malnutrition and shows an improvement in undernourishment of about 18% between the years of 2001 and 2011, which is above the 10% threshold level (FAO, 2014).

⁹ Details on the data sources and methodology used in the assessment can be found in Humann et al. (2015)

- Nevertheless, Cameroon has a Global Hunger Index (GHI) score value of 12.6, reflecting a serious level of hunger (von Grebmer *et al.*, 2014)¹⁰. This makes investments into the agriculture and food sector in Cameroon urgent in order to reduce the high numbers of food insecure people.

Table 15: Cameroon Performance Indicators

Indicator	Indicator score	Overall score
1. Number of years with more than 6% agricultural growth (2005 to 2014)	1	10
2. Percentage point change in TFP index between 2001 and 2008	7	30
3. Number of years with more than 10% government expenditure (2005 to 2014)	0	0
4. Average share of agricultural GDP spent on R&D (2005 to 2011) in %	na	na
5. Steps in CAADP completed	2	25
6. Percentage point improvement in undernourishment between 2001 and 2011	18.9	100
7. Global hunger index (2014)	12.6	30
Total score (weighted)		43

Data source: Husmann et al (2015)

Note: TFP refers to Total Factor Productivity

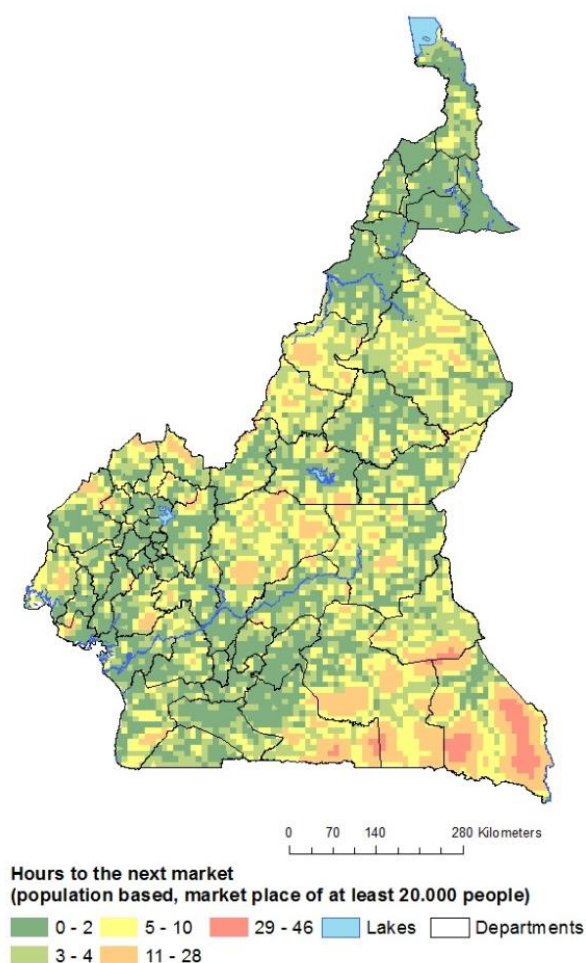
However, the overall economic, political, and social/nutrition framework in Cameroon does not seem to recommend increased investment into the agricultural and food sector of the country.

Nevertheless, Cameroon has potential for agricultural development, and this includes the country's large land resources. Cameroon has fertile lands covering 25% of its surface area, most of which have not been exploited. Due to the different agro-ecological zones, different agricultural activities can be pursued based on careful selection of sites. Rice can be grown in practically all regions of the country, and there is a long tradition of rice production among the local populations in the Great North, Northwest and West of the country. Lots of fruits are produced, but are wasted during peak seasons due to lack of processing channels. There are lots of water resources that could be used for irrigation, and there is a huge market for food products in the region, especially from CEMAC and Nigeria. Finally, labor is also readily available and cheap.

The selection of value chains to focus on 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 market place of at least 20,000 people in Cameroon.

¹⁰ 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 20 September, 2015

Inland water bodies: www.diva-gis.org/gData (water bodies), accessed 20 September, 2015

2 Most relevant value chains in Cameroon

2.1 GIC value chains

2.1.1.1 Poultry

Cameroon's annual poultry production amounts to approximately 30,000 tons, and its export are extremely low. The poultry meat sector is not a mainstay of the country's economy, as its contribution to GDP is estimated to be less than 1%. However, it plays an essential role for food security and income generation. The sector generates a yearly net profit of about US Dollars 30 million and contributes an estimated 9% of the animal protein consumed by the population. About 35% of total poultry meat production is produced in traditional village systems, which generate 65% of the poultry sector's annual net profits (FAO, 2011).

The domestic poultry sector benefits from a high degree of import protection, and domestic demand is projected to increase rapidly. Total demand for poultry meat in 2015 was estimated at 73,000 metric tons, of which 19,000 metric tons is for traditional chicken and 54,000 metric tons for commercial

broilers. Commercial and family farm-produced village chicken are treated differently because they are not internationally traded, they have a different flavor, and only 10% is sold in urban markets. Production at all levels is mainly based around Bafoussam (West Region) including the agro-industrial hatchery. Numerous consumers currently see village chickens as having a much better flavor than the commercial broilers, and there are indications that there is strong demand in the urban areas for this type of bird.

2.1.2 Cocoa

According to FAOSTAT (2012), Cameroon is ranked 14th in terms of world cocoa production with a total volume of about 256,000 metric tons. Cocoa is also the country's first commodity in terms of export value (Table 11). Cocoa is one of the best crops to increase income in households in forest communities in Cameroon. Cocoa is produced in all but the three northern regions, with highest production (about 80%) in three of the regions; Southwest (35%), Centre (28%), and South (16%). Unlike other cash crops, such as oil palm and rubber, only smallholders are involved in cocoa production-related activities. The cocoa development society, SODECAO, supports extension services to farmers. Production in the country has been increasing steadily from 1960 (600,000 tons) to 2005 (2,400,000 tons), and the country contributes 4% to world cocoa production.

After the harvesting and extraction of the beans (mostly done manually by family labor or hired labor), they are dried using ovens and then put into bags. These are sold to intermediaries who most often exploit the farmers (offer exploitatively low prices) due bad roads (no means to transport) or using false scales. Some of these intermediaries (licensed buyers) sell to local bigger exporting organizations, such as TELCAR COCOA LTD, to local cocoa processing companies in Douala or they export the cocoa beans to Europe themselves. A small amount of cocoa butter, paste and powder is produced in Cameroon and sold/consumed locally or sold to neighboring countries.

2.1.3 Onion

Onions have been cultivated for sixty years in the northern region of Cameroon. This has become the next most important cash crop for producers, after cotton and groundnuts, and it is one of the most traded vegetables in the country. The sector is a source of great economic returns to the North and Far North regions, which include more than 13,000 onion farmers producing 85% of the national output. Total production reached more than 225,000 tons in 2013 (FAOSTAT, 2016). Onions are marketed through a large informal trade network, spanning from production areas to markets in the southern regions and in neighboring countries (Maldangoï. et. al., 2003). The increase in urban demand for onions in Cameroon and the countries of the sub-region (Gabon, Equatorial Guinea, Central African Republic, Nigeria, Democratic Republic of Congo, Chad) shows that the vegetable is now part of the regular diet of the population. Individual onion consumption in Cameroon is estimated at about 1 kg per month (Cathala et. al., 2003).

2.2 Other relevant value chains

The other relevant value chains besides those selected for the GICs are discussed in this subsection. In this case, the relevance 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 Cassava

Cassava value chain plays an important role in food security in Cameroon. It represents about 18% of production volume and 16% of production value. Cassava products are part of the basic food intake of seven to eight million people in Cameroon, most of which live in the eight southern regions. Cassava is

the main staple food consumed in Cameroon. Cassava products also represent 60% of the market share of roots and tubers in the country (Emmanuel, 2013).

Most of the cassava is produced by smallholders (0.3 to 2 ha). Over 3.9 million tons were produced in 2011 and 4.3 million tons in 2012, topping the list for crop production volume. Most of the activities within the cassava value chain (planting, processing, and selling) are carried out by women. Cassava is eaten in different forms in the country: boiled, gari, fufu, bobolo, miondo, pounded, and the leaves are eaten as vegetables especially in the South and Centre Regions). To improve cassava production and marketing, several Farmer Field Schools have been established with about 25,000 producers involved, of which 53% are women. The country is self-sufficient in the production of cassava and already enjoys a high degree of competitiveness. Furthermore, demand for the product is growing in domestic and regional markets (especially Gabon and Equatorial Guinea).

2.2.2 Plantain and Banana

In Cameroon, bananas destined for export are mostly cultivated in large agro-industrial plantations (with a production capacity of 1.4 million metric tons). In terms of plantain production, Cameroon is ranked 8th in the world, with production increasing in quantity from 1.1 million tons in 1999, to 2.18 million tons in 2006, and finally to about 2.4 million tons in 2013. In the Central African Region, Cameroon is the largest producer and exporter, notably to countries such as Gabon, Congo, Equatorial Guinea, despite the country being ranked 2nd in plantain consumption (46 kg/person/year). Plantain is cultivated mainly in the Southern parts of the country (dominated by small-scale farmers and a few large-scale farmers practicing monocropping on several hectares), while banana for exports are concentrated in the Southwest, and Littoral Regions.

Around 650,000 farmers are involved in the production of plantains with more than 92% of them being small farmers and 60-70% having farms smaller than 2 ha. Consumption of these food crops is gradually increasing in the urban areas. About 40 kg/year of plantain per person is consumed in Douala and Yaounde (the two largest cities in Cameroon). Plantain production represents 4.5% of Cameroon's agricultural Gross Domestic Product, 16% of producers' income, and the annual consumption rate per person is 46 kg. In addition to selling fresh bunches, banana chips are produced, packaged and sold in stores or road side. In light of the government's emphasis on modernizing agriculture by 2035 and of its move to boost plantain/banana production, many investors and previous subsistence farmers are now considering establishing larger farms/plantations. This trend has resulted in an increasing demand for seedlings.

2.2.3 Maize

Cameroon is 46th in the world in terms of maize production, with a share of 0.2% of total world production. The total area of land harvested for the crop is 832,400 m². Total production of this crop has increased drastically from 280,000 metric tons in 1960 to 1,647,036 in 2013. It is the most widely grown crop in the country. In addition to being an important staple food in most parts of the country (especially in the grassland areas), it is also used to produce feed for livestock all over the country. Farmers sell either the fresh cobs or dry grains. Despite the importance of this crop, most farmers cultivate it in relatively small areas (0.4 to 0.6 hectares), and the country is not self-sufficient.

Until the late 1980s, maize was widely considered to be a crop only suitable for home consumption (can be roasted, boiled, eaten in the form of pudding, processed into flour, eaten as porridge or fufu, and fermented to make traditional beer) and not seen as a potential cash crop. However, with high demands from the brewery companies and livestock sector, its production is gaining more importance as a cash crop. The crop provides about 12% of the country's caloric and protein requirements. Generally, production is dominated by small-scale producers (low-input-use farms), although some medium-scale and large-scale producers are found in the Western and Savanna regions, respectively.

2.2.4 Cotton

Cotton is one of the six agricultural commodities that account for the lion's share of Cameroon's export revenues. Produced mainly in the Sudano-Sahalian and High Guinea Savannas of the Northern parts of the country cotton production is an important source of income for the populations in the relatively poorer Northern regions. This crop therefore represents a value chain with the potential to significantly reduce poverty and for export development. Seed cotton production in the country amounted to over 100,000 metric tons in 2003, and increased to 190,000 metric tons in 2012. Between 2000 and 2006, cotton exports represented between 20-25% of total agriculture exports. Production in Cameroon occurs mainly in the North and Far North Regions where the cotton system is managed as a more or less vertically integrated enterprise by the parastatal firm SODECOTON. Even though this company is not involved directly in field production, it enjoys official monopoly status on the purchase, processing, and marketing of all cotton in the country. However, it has important responsibilities for farmer extension, input procurement, and input distribution. Cotton is not irrigated and picking is exclusively by hand.

2.2.5 Oil Palm

In Cameroon, palm trees are mostly grown in Southern regions, in the tropical forests. Cameroon has the capacity to be an important palm oil exporter, but current domestic production does not meet total demand, hence the imports from countries such as Indonesia and Malaysia. Cameroon exports limited quantity of palm oil to its regional partners in CEMAC, but this could be expanded and displace imports from Southeast Asia to countries where Cameroon enjoys a clear transport advantage.

Cameroon is the 4th largest oil palm producer in Africa, and its production is steadily rising (from 44,000 metric tons in 1964, to 270,000 metric tons in 2014). Three types of producers contribute to the production of palm oil in the country: smallholders, commercial farms, and agribusinesses. Small holdings are characterized by low yield, low input use and reliance on family labor. Commercial farms operate more professionally, at a larger scale, use improved seeds, use more inputs and employ wage labor. Industrial plantations also use improved seeds, are highly mechanized, and employ wage labor. By global standards, per hectare yields in Cameroon are low, and this is mostly due to the use of poor quality seedlings by most smallholders and some commercial farmers.

2.2.6 Vegetables

Fresh vegetables production in Cameroon reached about 700,000 metric tons in 2012 and there were the 9th most produced crops in that same year. Although much research on traditional African vegetables (TAVs) still has to be done, and more government support to these crops is required, consumption of these vegetables is increasing, especially in urban areas.

Generally, vegetables are cultivated in all regions, but productions in West, Northwest, Southwest, Littoral, Center and South are the highest. In these areas, focus has been on the production of exotic vegetables, such as cabbage, tomatoes, lettuce, carrots etc. More women are active in the cultivation of leafy vegetables, and men in non-leafy vegetables, such as tomatoes, African garden egg, cabbage and pepper. Although the cultivated TAVs vary by region, common vegetables are African nightshade, amaranth, African eggplant, okra, *Telfeiria* (Okongobong), *Vernonia* (bitter leaf), and *Talinum* sp. (water leaf). Most of the vegetables are cultivated on the banks of streams/ponds/rivers/lakes (38.3%), fallows of plantations (10%) or in marshy areas (8.6%) and are hardly irrigated. With the exception of cabbage and tomatoes, which are sometimes cultivated on large areas (3-10 ha), the rest is cultivated on plots measuring a maximum of 0.2 ha. Vegetables are produced either for home consumption, or for sale. Farmers on the border, such as those in Ambam and Kiosi, take advantage of the high demand from neighboring Equatorial Guinea and Gabon.

2.2.7 Rubber

In Cameroon, natural rubber is produced by larger agro-industrial plantations such as the Cameroon Development Corporation (CDC), Hevea Cameroun (Hevecam), Société Agricole Forestière du Cameroun and PAMOL Plantations Plc (95%), as well as by smallholders (~ 5%). There are about 750 smallholdings with about 2,250 ha under cultivation. The only agro-chemicals used by most of these smallholders are stimulants to boost latex production. They also get improved planting materials in the form of budded seedlings from IRAD, CDC or experienced private nurseries.

Once rubber has been tapped and the cups are full of coagulated latex, it is put into jute bags and transported to nearby roads. Here, the harvest is given to CDC (to be paid later) or sold directly to Hevecam or private individuals who take the raw products to Nigeria. Within Cameroon, coagulated latex is brought to factories run by CDC or Hevecam, where it is processed into semi-finished rubber bales or sheets (mostly exported to Europe and few sold to local companies for the manufacturing of rubber goods). Unlike the oil palm sector, where many smallholders or groups of smallholders have access to private machines for oil extraction, access to machines producing semi-finished rubber products is not yet a reality for smallholders. Despite this, rubber is still referred to as 'white gold' by many people in the country.

2.2.8 Rice

Rice has become the most rapidly growing food source for millions of people. In 1984, average annual consumption of rice in the country was 11.5 kg/capita, accounting for 5.2% of households' food expenditure. Consumption rose to almost 24 kg/capita in 2013 (rice milled equivalent), with over 95% of the population eating rice at least once per week. Domestic production has never been able to meet demand, leading to huge imports (400,000 tons/year). Major rice cultivation areas are in the extreme or far North (Maroua and Kousseri) and North West (Ndop plains), with small cultivation areas in the West Region. The far North region currently has the highest production levels, with approximately 1,000 ha of land cultivated by some 1,100 traditional food farmers. Presently, the NERICA rice is gaining more importance. The country's production represents about 0.3% of Africa's total rice production. In 2012, paddy rice was the 20th most produced crop in the country, with an output of 181,818 metric tons. Most farms are irrigated (about 85%), some are in swampy areas and rainfed (10%) and a few are upland (5%). Harvesting is manual while milling is carried out by small scale milling units with an average capacity of 200 kg of milled rice per hour. It is mainly women who are involved in activities such sowing, weeding, threshing, winnowing, crop processing (drying, milling, and de-stoning) and distribution. Most farmers make use of family labor, and labor is therefore intensive.

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 16 below. The production share, RCA index, actual yield growth and relative yield gap for the GIC value chain(s) is 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 16: Selection of promising agricultural products /value chains

Rank by RCA			Rank by yield progress**		Rank by relevance of crop	
Rank	Name of agricultural product	RCA index (2011)*	Name of the crop	Average annual yield growth % (2005-2012)	Name of agricultural product	Production share of supply (2011)*
1	Pyrethrum, dried	58	Onions, dry	22	Beans	110
2	Cocoa, beans	36	Rice, paddy	16	Cocoa Beans and products	109
3	Bananas	7	Tomatoes	12	Sorghum and products	103
4	Rubber, natural	5	Bananas	11	Bananas	100
5	Cotton lint	4	Plantains	8	Roots, Other	100
GIC Selected products	Onions, dry	0.00	Cocoa, beans	2	onions	98

Source: * Own computation based on FAO 2015 data

Note: ** a minimum of 0.5% production (volume) share threshold is used as a screening (crop relevance) criteria.

Results of assessment (Table 16):

- The trade potential (RCA index) is high for dried pyrethrum, cocoa beans, bananas, natural rubber, cotton lint, and the cocoa beans selected by the GIC. This indicates that Cameroon has a comparative advantage (in the export) of these commodities. The RCA value for the other GIC-selected value chain, onion, is much lower than 1 indicating that Cameroon has a comparative disadvantage (in the export) of this commodity;
- The yield performance, which indicates progress, suggests that over the CAADP period (2005 to 2012) onion (GIC-selected value chain), paddy rice, tomatoes and bananas are the five most promising crops. Cocoa, the other GIC-selected crop, shows only a small growth in yield performance over the CAADP period;
- The leading crops in terms of relevance (production share of supply) are beans, sorghum, bananas, roots, and the GIC-selected cocoa value chains. The total production of the first three products exceeds the total supply (production + imports). The full supply of the latter two products is fully produced in the country. About 98% of the total supply of the other GIC-selected value chain, onion, is also locally produced.

2.4 Summary on the selection of agricultural products and value chains

This chapter (chapter 2) has presented different relevant and important value chains in Cameroon, based on different criteria – resulting in the selection of different value chains. In summary, the three top value chains in each set – GIC selected value chains, other relevant value chains, and those identified through the analysis of promising agricultural products and value chains – are presented in Table 17. The summary table shows that two of the GIC-selected value chains (onion and cocoa) are identified as promising by the analysis of promising agricultural products and value chains.

Furthermore, there are overlaps between the selection based on the literature review and the analysis of promising agricultural products and value chains. These products/value chains are banana, vegetables (tomatoes) and rice.

Table 17: Summary of all value chains

GIC value chains	Other value chains	Promising agricultural products and value chains (top 3)		
		RCA	Yield progress	Relevance of crop
Chicken	Cassava	Pyrethrum, dried	Onions, dry	beans
Cocoa	Plantain/ banana	Cocoa, beans	Rice, paddy	Cocoa beans & products
Onion	Maize	Bananas	Tomatoes	Sorghum & products
	Cotton			
	Oil palm			
	Vegetables			
	Rubber			
	Rice			

Source: Authors' compilation

3 Innovations in value chains in the past 20 years

Since most of the cash crops in the country are cultivated in large plantations and managed by agro-industrial companies, many innovations have been developed and applied for the cultivation, processing and marketing of these crops. Most importantly, best practices (for pests and pesticide management, land preparations, agronomic practices, harvesting, postharvest losses) are enforced, accompanied by stringent quality control, especially for consumables and export products. Over 95% of crops destined for domestic consumption are cultivated by small-scale farmers, most of whom are illiterate and continue to use traditional methods of cultivation.

3.1 Main limiting factors

Agriculture in Cameroon is faces a multitude of constraints:

- Low productivity of the smallholder systems: inefficient practices are still prevalent because improved practices require inputs that are not readily available or more expensive than the financial capacity of the smallholders;
- Limited public expenditure on agricultural research, extension and education: Public spending on agricultural projects and programs is financed mostly by development assistance under shared funding arrangements, whereby the Government contributes 20% or less to the total, while donors cover the rest;
- Limited mechanization: Cameroon has a low mechanization ratio, with few tractors each serving several hectares of arable land;
- Insufficient storage/processing facilities and marketing infrastructure: insufficient storage and marketing infrastructure is aggravated by the isolation of agricultural production areas because of the poor quality of rural roads;
- Limited access to credit/rural finance: peasant farmers have limited access to credit/rural finance because of) their inability to present viable projects for financing, the perceived high

cost of financing, and the absence of specific financial services/instruments for their segment;

- Poor value chain development for most commodities: this reduces the country to being a net producer of raw agricultural commodity and limits the margin of benefits;
- Lower competitiveness of rice and cotton: this is particularly due to trade protection and domestic support afforded to OECD¹¹ farmers, which lead to artificially low world market prices for those commodities.

The GIC value chains face the following specific challenges:

3.1.1.1 Cocoa

The low productivity and competitiveness (quality-related) in the cocoa sector is often due to the technical difficulties in accessing agricultural inputs and services, and the aging planters and cocoa trees. The most important inputs for cocoa production are improved planting materials and pesticides. Lack of access is due to the relatively high prices, which are sometimes inflated due to the isolation of the production areas and the poor structuring of producer cooperatives in many areas. In Cameroon, more than half of the plantations are more than 30 years old. Regeneration efforts are being made, although they remain very limited. Furthermore, the average age of producers in 2011 was 56 years, reflecting the low level of involvement of youth in cocoa production. Other problems include poor coordination of the value chain, scarce funding and climatic conditions that upset the agricultural calendar (Camernews, 2015).

3.1.1.2 Onion

The sector is marked by failed attempts to organize producers' associations. Even though they are sometimes supported by various projects, these initiatives are localized, disjointed and uncoordinated. Furthermore, there is also a lack of training of farmers. Information on new techniques and new cultivars are difficult to access. This results in poorly controlled use of fertilizers and plant protection techniques, as well as in the production of seeds whose quality is without guarantee. Important post-harvest losses are observed due to lack of storage facilities, long distances, and bad roads. Further, the natural barrier of the Adamawa region complicates marketing. Finally, the perishable nature of the product leads to an uneven flow of production and strong price fluctuations on the markets, which change according to the availability of supply. The organization of the entire value chain remains a major challenge (Cathala et. al., 2003).

3.1.1.3 Poultry

Broiler production on small and medium-size farms in Cameroon is stunted by poor growth due to inefficient feed use and high mortality. In addition, poor feeding and sanitary conditions, as well as farmers' lack of skills, resulting from a lack of training, negatively impact the sector, which also faces strong competition from imported frozen chicken (Teguia and Beynen, 2004).

3.2 Important value-chain related and cross-cutting innovations

In this section, we describe some of the key innovations that have been initiated in selected value chains in Cameroon in the last 20 years. The innovations described are considered significant or beneficial because of their widespread adoption, proven positive impact on increasing productivity, capacity for increasing incomes, adaptability to the environmental challenges (such as drought), employment creation potential, etc.

¹¹ Organization for Economic Co-operation and Development

3.2.1 GIC value chains

Several innovations have been developed in order to either increase cocoa producers' revenues, or to preserve biodiversity in the plantation areas. Some such innovations include the cocoa agroforestry landscapes (CALs) improvement and Non-timber forest products (NTFPs) cultivation. CALs improvement occurs by intercropping cocoa with fruit and timber trees, such as plantains, *Dacryodes edulis*, *Mangifera indica*, etc., and NTFPs schemes include planting species such as *Gnetum africana*, wild mangos, 'njangsa', etc. on the farms. These initiatives were created to limit farmers' heavy dependence on cocoa by providing alternative sources of revenues during off-seasons, and to prevent monoculture harming biodiversity. There is a high demand for fruit trees and NTFPs. These schemes apply to all farmers nationwide, especially those in the humid tropics zones of the country.

Another innovation in the cocoa sector includes vegetative propagation of cocoa through seeding, cutting, marcotting, tissue culture and grafting. Without these techniques, cocoa trees need a longer period to produce pods and beans. Farmers, producers, and marketers took interest in the techniques, and now most farmers in cocoa producing zones buy large quantities of improved cocoa seedlings that come mainly from vegetative propagation (Okolle et. al., 2016).

3.2.2 Other value chains and cross-cutting innovations

3.2.2.1 Cassava breeding and multiplication of disease-free planting materials

The cassava value chains created through the DONATA initiative have contributed to the rapid multiplication of disease-free cuttings, to the production of cassava products (e.g. *gari* and *bâtons de manioc*) of consistent quality, and to the better organization of cassava processing and marketing (e.g. group-based marketing). This project was carried out in the Centre region (6 innovation platforms), Littoral region (1 platform), South region (1 platform), and East region (2 platforms). In addition, in 2003, a project with the goal of improving the root and tuber sector was funded by IFAD and implemented by the Roots and Tubers National Development Program, a government agency. This national agency distributed IRAD/IITA's improved varieties across the country, notably the clone "8034", which is very productive and resistant to the cassava mosaic virus. Most small-scale cassava producers received disease-free planting materials for improved cassava varieties. Over 40% of women benefited from the project. The enthusiastic involvement of different stakeholders since the beginning of the project partly accounted for the successes of this project. However, after giving these planting materials, there is little follow up on the subsequent performance of the materials.

3.2.2.2 Improved Livestock Production System

IRAD works in collaboration with the International Atomic Energy Agency for the improvement of livestock productivity, food security and poverty reduction through artificial insemination and reproductive disease diagnostics. In recent years, more than 500 inseminations have been performed using oestrous synchronization, resulting in an approximate conception rate of 70%. Furthermore, the prevalence of Brucellosis has been reduced drastically as a result of the establishment of a control program, use of AI and the culling of infected animals. Female cow hybrids with a potential yield of 8-12 liters/day are available, which is much higher than the traditional breeds yielding 1-2 liters/day.

Crop/livestock value-chains were established in Ngaoundere and Guider regions of Cameroon as part of the "Sustainable Intensification of Integrated agriculture farming systems to increase the agropastoral productivity and food security in West and Central Africa" project, which was funded by AusAID and coordinated by the West and Central Africa Council for Agricultural Research and Development (CORAF/WE CARD). Crop/livestock farmers involved in the project benefited from improved crop-livestock integration techniques, improved forage crops, and livestock fattening methods. The value chains also contributed to increased revenues and wellbeing of producers in agropastoral systems.

3.2.2.3 Development and Dissemination of Improved Maize and Sorghum Seeds

Diageo, an alcoholic beverages company, launched a sorghum value chain initiative in 2008 in Cameroon. Through this initiative, smallholder sorghum farmers in the main sorghum-growing regions in northern Cameroon were provided with access to improved variety seeds and agricultural inputs, hands-on agronomic training and advice, and support in the development of storage and transport infrastructure. Diageo's initiative has stimulated the demand for sorghum and created a sustainable source of income for the farmers through sorghum yield increases. Diageo Company also benefits from a stable, secure source of sorghum for beer (Business Call to Action, undated).

As far as other cereals are concerned, many high yielding varieties have been developed and distributed to farmers in all the maize-growing regions of the country. Some recent hybrid varieties with high yields and tolerance to aluminium toxicity are TP S6 31Y-Bb x 9450 (8.5 t/ha), ATP-SR-Y (tolerant to acid soils), and C4RR SA4 x Cam Inb gp1 17 (8.3 t/ha). For sorghum, high-yielding new varieties that are adapted to local conditions have been distributed to farmers. Examples are Safari 40 (yellow), and Madjeri (white).

3.2.2.4 Dissemination and cultivation of improved beans and traditional vegetables

IRAD and the Center for Assistance for Sustainable Development, in partnership with AVRDC and with funding from CORAF/WE CARD, are distributing improved TAVs to farmers. These TAVs include amaranth, African nightshade, jute mallow, and African eggplant. The farmers have been trained and are now using best practices, which includes planting African Nightshade at a distance of 30x30 cm, which increases growth/yield and reduces insect infestations. Common bean (e.g. TY 3396-12, NITU, MEX-142, ECA PAN 021, MAC 55), and soy bean (TGX 1835-10 E) that are tolerant to mosaic and anthracnose disease have been selected and distributed to farmers. Through funding from the French Debt Reduction and Development Contract (C2D), and Pan-African Bean Research Alliance network, IRAD is able to test these varieties in different localities, distribute them to farmers and train farmers on best cultivation practices.

3.2.2.5 Rapid multiplication of plantains and promotion of best cultivation practices

CARBAP has developed many innovations as far as bananas and plantains are concerned. These innovations include rapid multiplication of plantains using macro-propagation technique, popularly known as the 'PIF' technique¹², cost-effective and environment-friendly ways of managing pests/diseases, and a new plantain hybrid – CRBP 039 – that is resistant to black sigatoka. The 'PIF' technique is widely used by smallholders to boost plantain production. With the C2D project, many demonstration plots have been established which focus on Integrated Pest Management, Best Cultivation practices. Furthermore, thanks to a partnership agreement between IRAD and MINADER, IRAD is producing over 5 million *in vitro* plantains (of highly demanded and common varieties). Plantain and sweet potato flour have been used to replace about 40% of the wheat flour used in bread-making.

3.2.2.6 Program for the Improvement of Competitiveness of the Agro-pastoral Family Farms

One of the major initiatives for the benefit of smallholder farmers taken by the government of Cameroon is the Program for the Improvement of Competitiveness of the Agro-pastoral Family Farms (ACEFA). The program was established in 2008, following an agreement between Cameroon and the French Development Agency (AFD). The program's aim is to improve the economic performance of major agro-pastoral sectors in Cameroon and to increase farmers' incomes.

¹² PIF refers to Plants issus de fragments de tige, which is a technique of deriving plants from stem fragments

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More specifically ACEFA strives to:

1. Improve the technical and economic management capacity of farmers and their groups;
2. Strengthen the capacity of production and marketing for agricultural products, by co-financing projects by producer groups (GP);
3. Improve the governance of groups and Professional Agricultural Organizations (OPAs) and improve their services to farms; strengthen the involvement of professional organizations in the development, implementation and monitoring of regional and national agricultural policies.

The program is implemented through three operational components:

Component 1: Support for Agricultural Family Farms (EFAs) and GPs. Under this component, action is taken to provide support and advice to EFAs, to set up an Observatory of EFAs and support the governance and management of OPAs.

Component 2: Financing GPs and OPAs projects. The aim is to develop the EFA production apparatus and sustainably generate income by co-financing joint GP and OPA investments at the production and downstream levels.

Component 3: Agro-pastoral Professionalization. The program continues its financial support for the operation of OPA platforms through grants awarded on the basis of a working plan and a budget that specifies the objectives, activities and expected results, and objectively verifiable indicators.

ACEFA is run through joint collaboration between the Ministry of Agriculture and Rural Development and of Livestock, and the Ministry of Fisheries and Animal Industries, with funding from C2D. ACEFA just completed its second phase, which ran from 2012 to 2016. Contrary to the first phase, which ran from 2008-2012 and covered only 5 regions (Adamawa, the North, West, South-West and South), the second phase extends activities nationwide to all 10 regions of the country. The results of the pilot phase showed tremendous impact in the 5 regions covered:

- 10 pilot departments established a new advisory support device,
- 237 Producer Group Advisors supported 2650 groups
- 27 Organizations Management Consultants accompanied 153 OPAs,
- 20 Technical Advisors specialized in plant and animal production,
- 10 Ranch Management Consultants followed 450 Family Farms,
- 1943 projects were funded with 6 billion FCFA.

The total cost of the first phase amounted to 17.7 billion FCFA, an equivalent of 27 million euros. 21.6 million euros out of the total cost were subsidized through the C2D compact.

The second phase of the program builds upon the achievements of the first phase, while extending its reach to the whole country. It puts particular emphasis on the advisory support service by increasing the number of consultants by department, prolonging the training period of advisors for better performance, and funding only the OPs that are accompanied by an advisor. The total cost of this phase is estimated at 60.3 billion FCFA or 91.9 million euros. Subsidies and loans from the AFD cover 85 million euros of that total (www.acefa.cm/en/; AFD, 2012).

Another promising initiative, despite difficulties in implementation, include Voluntary Insurance for the informal sector, especially for farmers and agri-entrepreneurs. The program was established through decree in August 13, 2014, providing an opportunity for those in the informal sector to receive an old age pension. At first, only civil servants and other formal sectors benefitted from this service. Despite the slow implementation and there being no current recipients of the service, many people in the informal sector praised the step taken by the government. Furthermore, the rising need to tackle the issue of increasing prices of food crops in rural areas led to the creation of the concept of Food crop production centers or zones. These centers will be established within each region to help fight

food insecurity in the rural areas. They will include warehouses for inputs and storage, tools, means of drying, means of processing, a loan and saving scheme, and a marketing aspect for the farmers (Okolle et. al., 2016).

4 Suggestions for Collaboration

Since Germany has much experience in agriculture, agro-processing and technology, a partnership with Germany could play an important role in shaping the agricultural sector in Cameroon, notably in the following areas:

- **Value addition:** Many food and cash crops are wasted because they are not being processed into other useful products that can be preserved for a longer time. Germany's technical know-how could encourage the processing of local raw material, for example, processing plantains and cassava into flour and starch, respectively;
- **Soil fertility management:** in light of the evidence showing declining soil fertility, German collaboration could help reverse the situation and therefore ensure increased crop yields for crops that heavily feed on soil nutrients, such as cassava and maize. Help in this area will focus on finding ways of increasing soil fertility by use of cost-effective and environment-friendly techniques, adapted to local conditions e.g. use of mycorrhizae, cover crops and the manufacturing and use of biofertilizers;
- **Capacity building:** Germany could help to train students and technicians in the fields of food technology and in the manufacture of small food processing machines;
- **Rapid diagnosis of diseases in animals:** Using advanced molecular techniques, certain serious animal diseases can be detected before signs appear or before the situation get worse. German and Cameroonian molecular researchers could work together to develop simple, rapid but cost-effective diagnostic field tools/kits;
- **German experience on innovation platforms:** The successes of Germany in the fields of science, technology and agro-processing cannot be over-emphasized. Germany's experience in setting up, operationalizing and sustaining an agricultural innovation platform is highly valued;
- **Conservation of cereals and legumes:** One major problem affecting cereals is the losses incurred after harvest. With German partners, appropriate techniques for drying and preserving these crops could be developed and applied so as to minimize post-harvest losses during storage;
- **Policy formulation:** With the help of trained German experts that have been and/or are involved with agricultural projects in Cameroon, Cameroon can benefit from recommendations that would help establish or build policies for certain agricultural sectors.

Potential collaborators include:

- a. Science and research:
IRAD; CARBAP; University of Ngaoundere; Biotechnology Units of University of Buea & Yaounde 1.
- b. Private sector, civil society and NGOs:
Agrochemical companies e.g. Agrochem, Syngenta, DuPont.
- c. Governmental organizations:
MINADER; Ministry of Livestock/Fisheries; SOWEDA; North West Farmers' Organization; CNOP-CAM.

References

- Abia, W. A., Warth, B., Sulyok, M., Krska, R., Tchana, A. N., Njobeh, P. B., Dutton, M. F. and Moundipa, P. F. 2013. Determination of multi-mycotoxin occurrence in cereals, nuts and their products in Cameroon by liquid chromatography tandem mass spectrometry (LC-MS/MS). *Food Control*, 31(2), 438-453
- ACEFA. 2017. Homepage. Accessed from: www.acefa.cm/en/
- Agence Française de Développement (AFD). 2012. Programme ACEFA: Bilan Phase 1 et enjeux Phase 2. AFD, Yaoundé, Cameroun.
- Arias, P., Hallam, D., Krivonos, E., & Morrison, J. 2013. Smallholder integration in changing food markets. Food and Agriculture Organization of the United Nations, Rome.
- Bhat, R. V. and Vasanthi, S. 2003. Mycotoxin food safety risk in developing countries. In: Unnevehr, L. J. (ed.). 2020 Focus 10: Food safety in food security and food trade. IFPRI, Washington DC
- Business Call to Action (undated) Diageo: Enabling Supply Chain Linkages in Cameroon.
- Cafiero, C. 2014. The excessive (and wasteful) consumption of food. Technical note 3. In: IFPRI. Global Nutrition Report 2014: Actions and Accountability to Accelerate the World's Progress on Nutrition. IFPRI, Washington, DC
- Camernews. 2015. Cameroun: Les contraintes de la filière cacao. Accessed on August, 26, 2016 from: www.camernews.com/cameroun-les-contraintes-de-la-filiere-cacao/#Yw1IHsdhwbp0adbo.99
- Cathala M., Woin N., Essang T. 2003. L'oignon, une production en plein essor au Nord-Cameroun. Jean-Yves Jamin, L. Seiny Boukar, Christian Floret. Cirad - Prasac, 8 pages.
- Chagomoka, T., Kamga, R., Tenkouano, A. and Mecozzi, M. 2014. Traditional Vegetables: Recipes from Cameroon. AVRDC – The World Vegetable Center, Shanhua, Taiwan.
- DFID. 2004. "Agriculture, Growth and Poverty Reduction", www.dfid.gov.uk/Documents/publications/agri-poverty-reduction.pdf
- Ediage, E. N., Hell, K. and De Saeger, S. 2014. A comprehensive study to explore differences in mycotoxin patterns from agro-ecological regions through maize, peanut, and cassava products: a case study, Cameroon. *Journal of Agricultural and Food Chemistry*, 62(20), 4789-4797
- Emmanuel, T. 2013. Enhancing Cassava Marketing and Processing in Cameroon: Drivers, Constraints, and Prospects of the Value Chain, In: Rebuilding West Africa's Food Potential, A. Elbehri (ed.), FAO/IFAD.
- EuroStat IMF (undated). World trade excluding inter-region trade and top partners excluding region member states. Accessed from: dsbb.imf.org/pages/sdds/EuroStatNote.aspx
- FAO. 2014. The State of Food Insecurity in the World 2014. Rome: FAO, WFP, IFAD.
- FAO. 2016. Food security indicators. Retrieved June 17, 2016, from www.fao.org/economic/ess/ess-fs/ess-fadata/en/
- FAOSTAT. 2017. Food and agriculture data. Last accessed on January 16, 2017 from: www.fao.org/faostat/en/#home
- Fuglie K. and Rada N. 2011, „Policies and productivity growth in African agriculture“, in Agricultural R&D: Investing in Africa's Future. Analyzing Trends, Challenges and Opportunities, Bd. 19 (ASTI/IFPRI-FARA Conference, Accra, Ghana: Citeseer, 2011), citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.371.9698&rep=rep1&type=pdf.

- Gong, Y., Hounsa, A., Egal, S., Turner, P. C., Sutcliffe, A. E., Hall, A. J., Cardwell, K., Wild, C. P. 2004. Postweaning exposure to aflatoxin results in impaired child growth: a longitudinal study in Benin, West Africa. *Environmental Health Perspectives*, 112(13), 1334-1338
- HarvestChoice. 2015. Travel time to nearest town over 20K (mean, hours, 2000). International Food Policy Research Institute, Washington, DC., and University of Minnesota, St. Paul, MN. Available online at harvestchoice.org/data/tt_20k
- HarvestPlus. 2017. What we do: crops. Accessed online at www.harvestplus.org/what-we-do/crops
- Husmann C., von Braun J., Badiane O., Akinbamijo Y., Fatunbi A.O., Virchow D. 2015. Tapping Potentials of Innovation for Food Security and Sustainable Agricultural Growth – an Africa-wide Perspective. Program of Accompanying Research for Agricultural Innovation (PARI). Bonn: Center for Development Research.
- ICF International. 2015. The DHS Program STATcompiler. Last accessed on September 12, 2016 from: www.statcompiler.com/en/
- IFPRI. 2015. Global Nutrition Report 2015: Actions and Accountability to Advance Nutrition and Sustainable Development: Nutrition Country Profiles. IFPRI, Washington DC.
- Imdad, A., Herzer, K., Mayo-Wilson, E., Yakoob, M. Y. and Bhutta, Z. A. 2010. Vitamin A supplementation for preventing morbidity and mortality in children from 6 months to 5 years of age. *Cochrane Database of Systematic Reviews*, 12, CD008524
- Imdad, A., Yakoob, M. Y., Sudfeld, C., Haider, B. A., Black, R. E., Bhutta, Z. A. 2011. Impact of vitamin A supplementation on infant and childhood mortality. *BMC Public Health*, 11(Suppl 3), S20
- Institut National de la Statistique (INS) and ICF International. 2012. Enquête Démographique et de Santé et à Indicateurs Multiples du Cameroun 2011. INS and ICF International, Calverton, Maryland.
- Institut National de la Statistique (INS). 2015. Enquête par grappes à indicateurs multiples (MICS5), 2014, Rapport de résultats clés. INS, Yaoundé.
- Kana, J. R., Gnonlonfin, B. G. J., Harvey, J., Wainaina, J., Wanjuki, I., Skilton, R. A. and Teguaia, A. 2013. Assessment of aflatoxin contamination of maize, peanut meal and poultry feed mixtures from different agroecological zones in Cameroon. *Toxins*, 5(5), 884-94
- Lewis, W. A. 1962. Education and economic development. *Caribbean Quarterly*, 7(4), 171-184.
- Maldangoi Y., Woin N., Cathala M. 2003. Les producteurs d'oignons du Nord-Cameroun: les défis d'une filière à la quête d'une place au soleil. Jean-Yves Jamin, L. Seiny Boukar, Christian Floret. Cirad - Prasac, 8 pages.
- Must, A. and McKeown, N. M. 2012. The disease burden associated with overweight and obesity. In: De Groot, L. J., Beck-Peccoz, P., Chrousos, G., Dungan, K., Grossman, A., Hershman, J. M., Koch, C., McLachlan, R., New, M., Rebar, R., Singer, F., Vinik, A., and Weickert, M. O. (editors). *Endotext*. MDText.com, Inc., South Dartmouth (MA). Retrieved October 10, 2016, from <https://www.ncbi.nlm.nih.gov/books/NBK279095/>
- Okolle J.N., Oumarou P.M., Almeck A.D., Ntam F., Ngane B., Suh C., Mounjouenpou P., Akoa Etoa J.M., Mfoumou E.C., Ngatchou A., Mveng P., Ngome A.F., Meliko M.O., Pompidou D.F., Nyambi G., Woin N. (2016). Status of Agricultural Innovations, Innovation Platforms, and Innovations Investment. 2015 PARI project country report: Republic of Cameroon. Accra and Bonn: Forum for Agricultural Research in Africa (FARA) and Center for Development Research (ZEF), University of Bonn.
- PAHO/WHO. 2003. Guiding principles for complementary feeding of the breastfed child. PAHO, Washington DC.

Program of Accompanying Research for Agricultural Innovation (PARI)

- Rapsomanikis, G. 2014. The economic lives of smallholder farmers; An analysis based on household surveys. Rome: Food and Agriculture Organization.
- ReSAKSS. 2017. Homepage. Accessed from: resakss.org/
- Scaling Up Nutrition. 2017. Homepage. Accessed from: scalingupnutrition.org/
- Stevens, G. A., Bennett, J. E., Hennocq, Q. et al. 2015. Trends and Mortality Effects of Vitamin A Deficiency in Children in 138 Low- and Middle-Income Countries: Pooled Analysis of Population-Based Surveys. *Lancet*, 3(9), e528–e536
- Tchana, A. N., Moundipa, P. F. and Tchouanguep, F. M. 2010. Aflatoxin Contamination in Food and Body Fluids in Relation to Malnutrition and Cancer Status in Cameroon. *International Journal of Environmental Research and Public Health*, 7(1), 178-188
- Teguia A and Beynen A. C. 2004: Nutritional aspects of broiler production in small-holder farms in Cameroon. *Livestock Research for Rural Development*, Vol. 16, Art. #7. Accessed on August 26, 2016, from: www.lrrd.org/lrrd16/1/tegu161.htm
- UNICEF. 2013. Improving child nutrition: The achievable imperative for global progress. UNICEF, New York.
- UNICEF/WHO/World Bank. 2016. Levels and Trends in Child Malnutrition: UNICEF-WHO-The World Bank: Joint Malnutrition Estimates, August 2016. New York, Geneva, and Washington, DC. Retrieved September 26, 2016, from who.int/nutgrowthdb/estimates2015/en/
- University of Oxford (2015). The Malaria Atlas Project. www.map.ox.ac.uk/ . Accessed 22 Nov 2016
- USDA (US Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory). 2016. USDA National Nutrient Database for Standard Reference, Release 28 (Slightly revised). Retrieved October 5, 2016, from www.ars.usda.gov/ba/bhnrc/ndl
- von Grebmer K., Saltzman A., Birol E., Wiesmann D., Prasai N., Yohannes Y., Menon P., Thompson J. and Sonntag A. 2014. 2014 Global Hunger Index: The Challenge of Hidden Hunger. Bonn/Washington D.C./Dublin: Welthungerhilfe, International Food Policy Research Institute (IFPRI), Concern Worldwide.
- WHO. 1995. Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. Technical Report Series 845, WHO, Geneva.
- WHO. 2000. The Management of Nutrition in Major Emergencies. WHO, Geneva.
- WHO. 2003. Nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation. Technical Report Series 916, WHO, Geneva.
- WHO. 2005. Guiding principles for feeding non-breastfed children 6-24 months of age. WHO, Geneva.
- WHO. 2010. Indicators for Assessing Infant and Young Child Feeding Practices, Part 1: Definitions. WHO, Geneva.
- WHO. 2015a. Global Health Observatory Data Repository: Adult overweight and adult obesity. Retrieved September 15, 2016, from apps.who.int/gho/data/node.main.A897A?lang=en and apps.who.int/gho/data/node.main.A900A?lang=en
- WHO. 2015b. The Global Prevalence of Anaemia in 2011. WHO, Geneva.
- WHO/FAO/UNU. 2007. Protein and amino acid requirements in human nutrition. Report of a joint FAO/WHO/UNU expert consultation. Technical Report Series 935, WHO, Geneva.
- World Bank. 2006. Repositioning Nutrition as Central to Development: A Strategy for Large-Scale Action. World Bank, Washington DC.
- World Bank. 2017. Country data. Retrieved from data.worldbank.org/country

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/m² (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/m² (ICF International, 2015, The DHS Program STATcompiler).

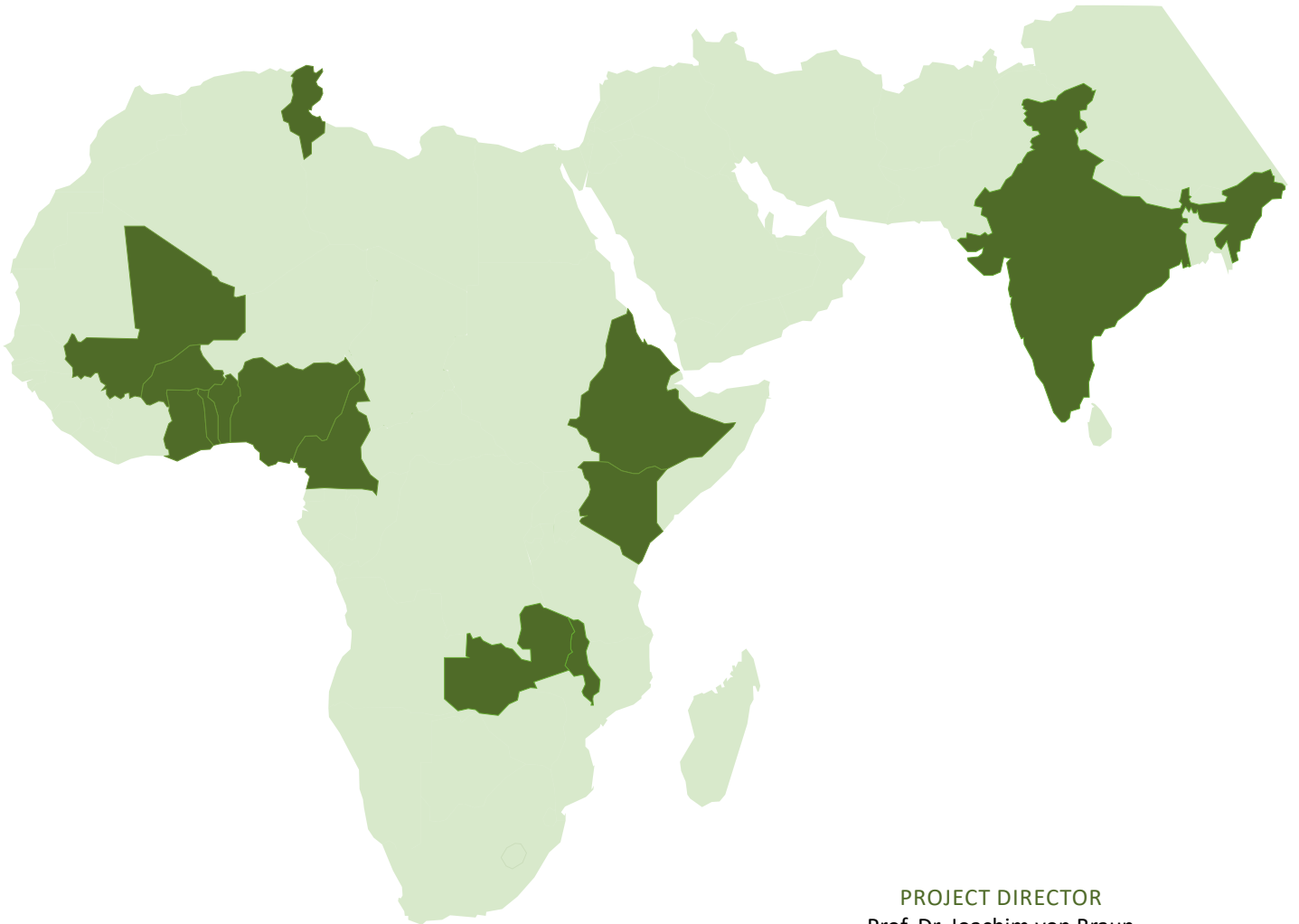
Vitamin A deficiency: Percentage of children aged 6-59 months with a serum retinol concentration below 0.7 µmol/l.

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.



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