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# Innovation for Sustainable Agricultural Growth in Benin

PARI

*Program of Accompanying Research for Agricultural Innovation*

**OCTOBER 2017**
research4agrinnovation.org

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**SUGGESTED CITATION:**

ZEF, FARA, INRAB (2017). *Country Dossier: Innovation for Sustainable Agricultural Growth in Benin*. Program of Accompanying Research for Agricultural Innovation. Bonn, Accra and Cotonou: Center for Development Research, Forum for Agricultural Research in Africa and Institut National des Recherches Agricoles du Bénin.

**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).

Federal Ministry
for Economic Cooperation
and Development

## 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

| | |
|---|---|
| AfricaRice | Africa Rice Center |
| AU | African Union |
| CAADP | Comprehensive Africa Agriculture Development Programme |
| CARDER | Centre d'Action Régional Pour le Développement Rural / Regional Action Centre for Rural Development |
| CeRPA | Centre Régional de Promotion de L'Agriculture / Regional Center for Agricultural Promotion |
| CIRAD | Centre de coopération internationale en recherche agronomique pour le développement/ French Agricultural Research Centre for International Development |
| DAPS/MDR | Direction de l'Analyse, de la Prévision et de la Synthèse du Ministère du Développement Rural/ Analysis, Forecasting and Synthesis Direction of the Ministry of Rural Development |
| DHS | Demographic and Health Survey |
| DICAF | Direction du Conseil Agricole et de la Formation Opérationnelle / Department of Agricultural Council and Operational Training |
| ECOWAS | Economic Community of West African States |
| FAO | Food and Agriculture Organization |
| FARA | Forum for Agricultural Research in Africa |
| FA/UP | Faculté d'Agronomie de l'Université de Parakou/ Department of Agronomy of the University of Parakou |
| FFF | Farmer Field Fora |
| FSA/UAC | Faculté des Sciences Agronomiques / Université d'Abomey-Calavi / Department of Agricultural Sciences/University of Abomey-Calavi |
| 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 |
| IFPRI | International Food Policy Research Institute |
| IITA | International Institute of Tropical Agriculture |
| INRAB | Institut National des Recherches Agricoles du Bénin / National Institute of Agricultural Research of Benin |
| MAEP | Ministère de l'Agriculture, de l'Elevage et de la Pêche / Ministry of Agriculture, Animal Husbandry and Fisheries |
| MSPs | Multi-stakeholder Platforms |
| NARES | National Agricultural Research and Extension Systems |
| NARS | National Agricultural Research System |
| NGO | Non-Governmental Organization |
| ONASA | Office national d'appui à la sécurité alimentaire/ National Food Security Support Office |
| PARI | Program of Accompanying Research for Agricultural Innovation |
| PNISA | Plateforme Nationale pour l'Innovation dans le Secteur Agricole/ National Platform for Innovation in the Agricultural Sector |
| PPP | Purchasing Power Parity |
| PSRSA | Plan Stratégique de Relance du Secteur Agricole/ Strategic Plan to Boost the Agricultural Sector |
| R&D | Research and Development |
| RCA | Revealed Comparative Advantage |
| SDO | Strategic Development Orientations |

| | |
|---|---|
| SEWOH | "One World, No Hunger" Initiative |
| TFP | Total Factor Productivity |
| UNICEF | United Nations International Children's Emergency Fund |
| USAID | United States Agency for International Development |
| VIP | Varietal Innovation Platform |
| WHO | World Health Organization |
| ZEF | Zentrum für Entwicklungsforschung / Center for Development Research |

# 1 General background information on the agricultural and food sectors

The Republic of Benin is a coastal country in West Africa. With a stretched-out shape in latitude, Benin covers a surface area of 114,763 square kilometers, delimited in the South by the Atlantic Ocean, in the West by Togo, in the North by Burkina Faso and Niger and in the East by the Federal Republic of Nigeria. Benin has close to 11 million inhabitants (in 2015). The average annual Gross Domestic Product (GDP) growth rate fluctuated between 1.7 and 7.2% in the last decade. Just over half of the population (56%) is living in rural areas, although the share is showing a downward trend.[1]

Benin's economy is mainly based on agriculture. According to the Ministry of Agriculture, Livestock and Fisheries, the agricultural sector contributes around a third to the GDP, a quarter to the export earnings and 15% to government revenues, and generates employment for about 70% of the people (Ministry of Agriculture, Animal Husbandry and Fisheries (MAEP), 2015). The agricultural production sector is characterized by the predominance of smallholder farming, which is vulnerable to climate change and extreme climate events. After a decline in 2010, there has been an increase in the growth of agricultural GDP from 1.5% in 2010 to 6.5% in 2014. The revenues and productivity factors are low and the labor force is only partially valued; a situation that makes agricultural products less competitive. Most farm operators use insufficient fertilizers and undertake mining activities, thus increasing the degradation of natural resources.

In Benin, there are opportunities to boost agricultural growth and thereby economic growth, with positive spillovers on food security. To do this, agricultural policy promotes several actions including improving soil management and natural resources, improving access to markets and capturing new markets, implementation of institutional reforms, improving investments and coordinating research, and transfer of agricultural innovations. All these initiatives are recorded in the Strategic Plan to Boost the Agricultural Sector (PSRSA 2011-2015) that is perfectly in line with the Pan-African and international agricultural development instruments.

There is a huge potential for cooperation between Germany and Benin for agricultural growth and development. This includes agricultural research partnerships for technology generation and the implementation of systems and means to transfer and add value to the innovations for the benefit of agricultural producers and sustainable development.

In twelve African countries, including Benin, 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 Benin are rice, soya and poultry meat. The regions of focus are Borgou-Alibori and Zou-Collines.

## 1.1 Pan-African policies and strategies

Benin was among the first countries to sign a Comprehensive Africa Agriculture Development Programme (CAADP) compact. This Pan-African Program developed by the Commission of the African Union (AU) under the New Partnership for Africa's Development follows the Maputo declaration in 2003 and represents the commitment of African countries to allocate at least 10% of their budget to agriculture in a global vision to induce an annual growth of 6% of the sector.

Benin is one of the West African countries that have adopted the agricultural policy of the Economic Community of West African States (ECOWAS) in 2005 to ensure food security, economic and social development and poverty reduction in the region. The country joined the New Alliance for Food and Nutritional Security in 2013, with the commitment to ensure an inclusive and sustainable agricultural growth in the country. To this end, actions and policies should be directed towards improving the

[1] Data from World Bank, databank.worldbank.org, accessed Jan. 2017

business environment, supporting land ownership, nutrition, gender, institutional reforms, resilience and risk management, trade and access to product markets.

Benin is also member of the Grow Africa Partnership. This is a Multi-Stakeholder Platform (MSP) whose goal is to accelerate investments in the agricultural private sector of the 12 member States. In 2013, an investment of US$ 30 million was achieved, 13,430 households were reached and 326 jobs created in Benin by national and international companies through the Grow Partnership and the New Alliance for Food Security and Nutrition Initiatives.

## 1.2 National (and regional) policies and strategies

### a. Strategic Development Orientations (SDO)

The strategic development orientations (SDO) document of Benin, elaborated to serve as a compass for the regime change over the period 2006-2011, identifies two major objectives (i) to develop growth hubs and (ii) to reduce poverty and improve quality of life. The SDOs of Benin plan to promote an economic renewal by putting in place an institutional environment with international standard and production diversification, particularly in the rural areas. In the agricultural sector, the objective of the SDO is to make Benin a modern, dynamic, competitive and wealth creating agricultural country through the following actions:

- Mechanization adapted to the different agro-ecologic conditions;
- Water control;
- Promoting research and improved seeds;
- The development of, and providing information on, improved storage/conservation technologies and processing of plant, animal, fisheries and forest products;
- Exempting agricultural inputs and materials from customs duties;
- The creation of regional agricultural product markets;
- Strengthening the capacities of producers and supervisory structures;
- Funding agriculture through the creation of a Nation Agricultural Development Fund, working out a code for agricultural investment and the creation of an agricultural bank.

### b. Strategic Plan to Boost the Agricultural Sector (PSRSA 2011-2015)

In 2008, Benin adopted a strategy for agricultural diversification and development, which is known as PSRSA. The vision of PSRSA is to make “Benin a powerful dynamic agricultural powerhouse by the year 2015, competitive, environmentally safe, creating wealth and meeting the needs of economic and social development of the population”.

The global diagnosis of the agricultural sector carried as part of the PSRSA development process reveals that Benin agriculture has to meet three major challenges. These are:

- Meeting food and nutritional needs of the population (13 million inhabitants by 2015);
- Improving the productivity and competitiveness of the agricultural and rural sector, ensuring an increase in the revenues of agricultural producers, meeting nonfood needs (health care, education and others), as well as ensuring the contribution of the sector to the national economic growth;
- Improving the attractiveness of the agricultural activity and the rural area by creating the necessary conditions in the different agro-ecologic zones of Benin, thus making agriculture attractive, improving employment and livelihood conditions in the rural area and stabilizing dynamic forces, namely youth and women.

PSRSA’s global objective is to “improve the performance of Benin’s agriculture to enable it to ensure sustainable food sovereignty of the population and to contribute to the economic and social development of Benin, achieving the Millennium Development Goals and poverty reduction” (New Alliance, n.d.).

From an operational point of view, nine items have been identified as action areas for the implementation of the PSRSA. These are:

- Strengthening the availability and accessibility of quality seeds;
- Strengthening the accessibility of inputs;
- Adapting agricultural mechanization activities and making them accessible;
- Putting in place adapted and accessible funding;
- Facilitating access to markets;
- Improving access to professional knowledge and technological innovations;
- Developing and operationalizing agricultural schemes;
- Securing and managing access to lands;
- Professionalizing family farms and promoting vast cultivation and agricultural entrepreneurship.

**c. National long-term vision "Benin Alafia 2025"**

The document of the national long-term vision "Benin Alafia 2025" highlights eight strategic orientations from which the strategic options are derived that are operationalized through strategic lines. The agricultural sector, agricultural research, the development and dissemination of innovations appear at several levels. Agricultural development strategies are on the first line of the six options envisaged to build a strong and sustainable economy. They advocate "a better regional specialization in the diversification of agricultural production". These strategies envision transforming "Benin into a big agricultural product exporter" by 2025. The key strategies to reach this vision include:

- Strengthening poverty control in a secured environment;
- Promoting a country development strategy that ensures regional development and a rational environmental management;
- Promotion of a culture and environment favorable to technological development;
- Strengthening human and material bases of the economy that aims to build a prosperous and competitive economy by 2025.

## 1.3 Data on food and nutrition security in Benin 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*

According to the statistics of the World Bank[2] in 2011, 52% of Benin's population spent less than US$ 1.25 per day. Poverty is higher in the rural areas than in the urban areas, with an increase in inequality between men and women. In 2011, the rural population living on the poverty threshold was 40% of the national population. Table 1 summarizes the main information on the economic and social situation in Benin, while Table 2 presents the contribution of agriculture to Benin's GDP.

[2] data.worldbank.org/country

**Table 1: Selected national economic and social data**

| Indicator | Value | Year |
|---|---|---|
| **Basic facts about agriculture sector** | | |
| Population, total | 10,599,510 | 2014 |
| Population growth (annual %) | 2.6 | 2014 |
| Rural population (% of total population) | 56 | 2014 |
| Socio economic and poverty | | |
| GDP per capita, PPP (constant 2011 international $) | 1,779 | 2014 |
| GNI per capita, PPP (constant 2011 international $) | 1,767 | 2014 |
| Poverty headcount ratio at $ 2 a day (PPP) (% of population) | 74 | 2011 |
| Poverty headcount ratio at $ 1.25 a day (PPP) (% of population) | 52 | 2011 |
| Poverty headcount ratio at national poverty lines (% of population) | 36 | 2011 |
| Rural poverty headcount ratio at national poverty lines (% of rural population) | 40 | 2011 |
| Ratio of female to male secondary enrollment (%) | 66 | 2013 |
| Mortality rate, under-5 (per 1,000 live births) | 85 | 2013 |
| Maternal mortality ratio (modeled estimate, per 100,000 live births) | 340 | 2013 |
| Agriculture and rural area | | |
| Agricultural land (% of land area) | 33 | 2012 |
| Agricultural irrigated land (% of total agricultural land) | no data | |
| Agriculture value added per worker (constant 2005 US$) | 1,278 | 2015 |
| Agriculture, value added (% of GDP) | 36 | 2014 |
| Access to electricity, rural (% of rural population) | 15 | 2012 |
| Employees, agriculture, female (% of female employment) | 33 | 2003 |
| Employees, agriculture, male (% of male employment) | 53 | 2003 |
| Employment in agriculture (% of total employment) | 43 | 2003 |
| Literacy rate, adult total (% of people ages 15 and above) | 29 | 2006 |

Source: World Bank, data.worldbank.org/country

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

**Table 2: Overall agricultural growth**

| Years | Contribution of agriculture to GPD (%) | Agriculture GPD (billion XOF) |
|---|---|---|
| **1995** | 22.7 | 358.4 |
| **1996** | 25.0 | 431.3 |
| **1997** | 25.2 | 437.7 |
| **2005** | 37.5 | 370.0 |
| **2006** | 38.2 | 390.2 |
| **2007** | 31.3 | 406.7 |
| **2008** | 32.3 | 421.2 |
| **2009** | 32.4 | 431.9 |
| **2010** | 32.4 | 438.0 |
| **2011** | 32.8 | 455.0 |

Source: National Accounts Service, Benin (2015)

### *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 Benin, exceeding the average dietary energy requirement of the population by more than one fourth (Table 3).

**Table 3: Food and nutrition security indicators**

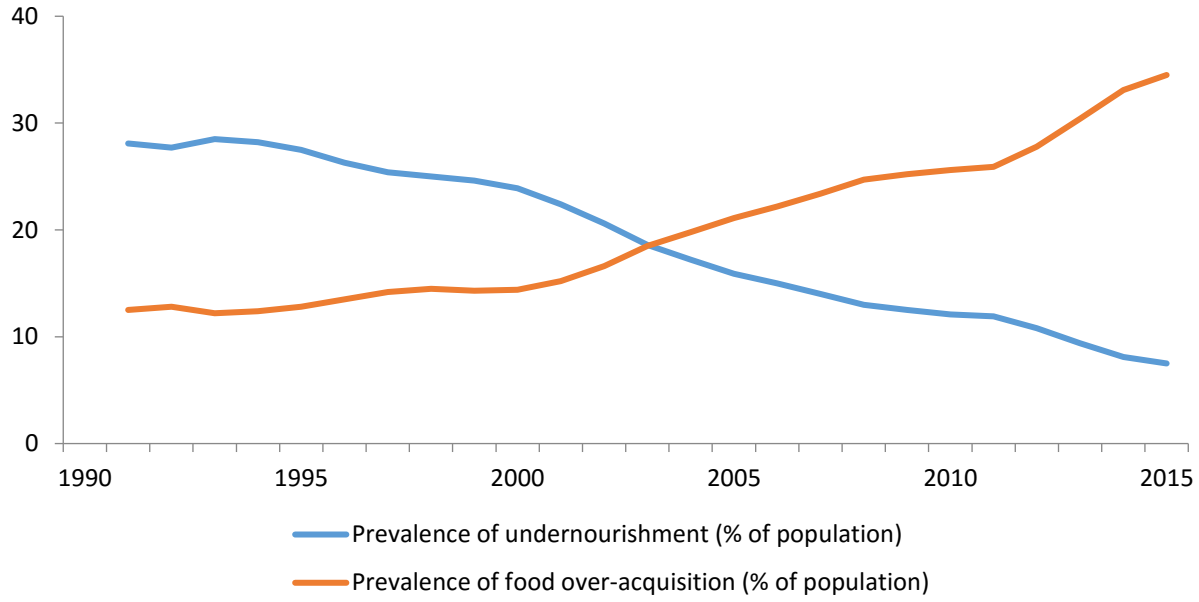
| Indicator | Value | Year |
|---|---|---|
| ***Diet quantity*** | | |
| Dietary energy supply (kcal/caput/day) | 2798 | 2014-16 |
| Average dietary energy supply adequacy (% of average requirement) | 127 | 2014-16 |
| Prevalence of undernourishment (% of population) | 8 | 2014-16 |
| Prevalence of food over-acquisition (% of population) | 35 | 2014-16 |
| ***Diet quality*** | | |
| Dietary energy supply from cereals, roots and tubers (% of total dietary energy supply) | 72 | 2009-11 |
| Dietary energy supply from carbohydrates (% of total dietary energy supply) | 73 | 2009-11 |
| Dietary energy supply from protein (% of total dietary energy supply) | 9 | 2009-11 |
| Dietary energy supply from fat (% of total dietary energy supply) | 17 | 2009-11 |
| Average protein supply (g/caput/day) | 61 | 2009-11 |
| Average fat supply (g/caput/day) | 49 | 2009-11 |
| ***Child feeding practices*** | | |
| Minimum dietary diversity: consumption of 4+ food groups (% of children 6-23 months) | 32 | 2011-12 |
| Consumption of foods rich in vitamin A (% of children 6-23 months) | 54 | 2011-12 |
| Consumption of foods rich in iron (% of children 6-23 months) | 39 | 2011-12 |
| ***Nutrition status*** | | |
| Child wasting (% of children under five) | 5 | 2014 |
| Child stunting (% of children under five) | 34 | 2014 |
| Child overweight (% of children under five) | 2 | 2014 |
| Adult overweight and obesity (% of adults 18+ years) | 29 | 2014 |
| Adult obesity (% of adults 18+ years) | 9 | 2014 |
| Vitamin A deficiency (% of children 6-59 months) | 53 | 2013 |
| Anemia in children (% of children 6-59 months) | 58 | 2011-12 |
| Anemia in women (% of women 15-49 years) | 41 | 2011-12 |

Source: FAO (2016), and authors' calculations based on FAO (2016); Institut National de la Statistique et de l'Analyse Economique (2015); Institut National de la Statistique et de l'Analyse Économique and ICF International (2013); 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.

Less than 10% of the population suffers from chronic undernourishment, defined as an inability to meet their minimum dietary energy requirements. Benin has managed to reduce the prevalence of undernourishment greatly since 1990-92, by almost three quarters (Figure 1). The prevalence of food-over acquisition began to rise steeply in the early 2000s. The Food and Agricultural Organization of the United Nations (FAO) estimates that more than one third of the Beninese population regularly acquires food in excess of their dietary energy needs (Table 3).

The diet in Benin strongly relies on starchy staples (mainly rice, yams, cassava, and maize) that provide more than 70% of dietary energy supply (Table 3). While the shares of dietary energy supply from carbohydrates and fat are within the recommended ranges of 55-75% and 15-30%, respectively, the share of dietary energy supply from protein is below the recommended minimum of 10% (WHO, 2003). The imbalance in the composition of the diet can be traced back to abundant supplies of carbohydrates and dietary energy: Average protein supply is sufficient to meet protein requirements and would be adequate for a diet that matches the average dietary energy requirement of the population (Table 3; see Annex A for further explanation).

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



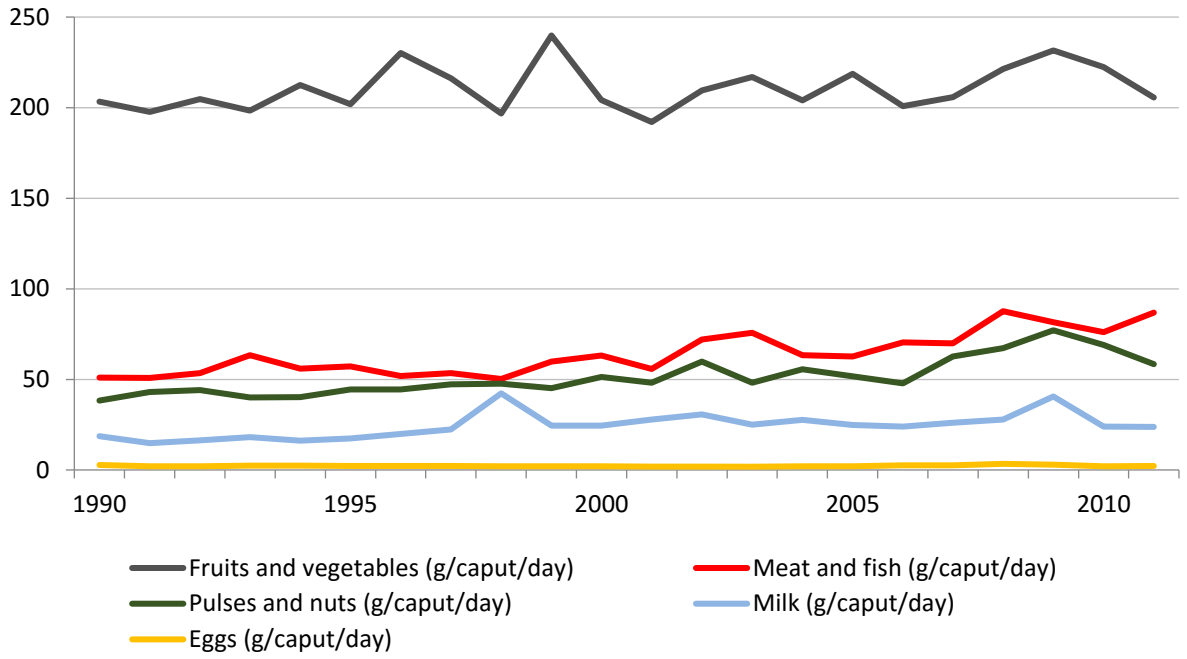

Source: Authors' presentation based on data from FAO (2016)

The consumption of sufficient quantities of non-staple foods such as fruits and vegetables and animal-source foods is essential for a diet that provides adequate micronutrients. Meat and fish supply has increased by 70% since 1990, but is still below 100 g/caput/day (Figure 2). Milk supply is even lower and has shown inconsistent and limited growth, while eggs play only a very minor role in the national diet. The supply of pulses and nuts has reached roughly 60 g/caput/day, providing more than one fifth of protein supply in Benin.[3] The supply of fruit and vegetables has been variable; according to the latest data, it amounts to only about half the recommended intake of 400 g of fruits and vegetables per day (WHO, 2003).

Infant and young child feeding practices are crucial for children's nutrition, 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 Benin, infants' and young children's diets fall short of these goals: roughly one third achieved minimum dietary diversity, 54% consumed foods rich in Vitamin A, and about two fifths had foods rich in iron on the previous day (Table 3). Both breastfed and non-breastfed children aged 6-23 months were most frequently fed foods made from grains; other, more micronutrient-rich foods such as meat, fish and eggs, fruits and vegetables rich in vitamin A, and pulses and nuts, were given more rarely (Figure 3). 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.

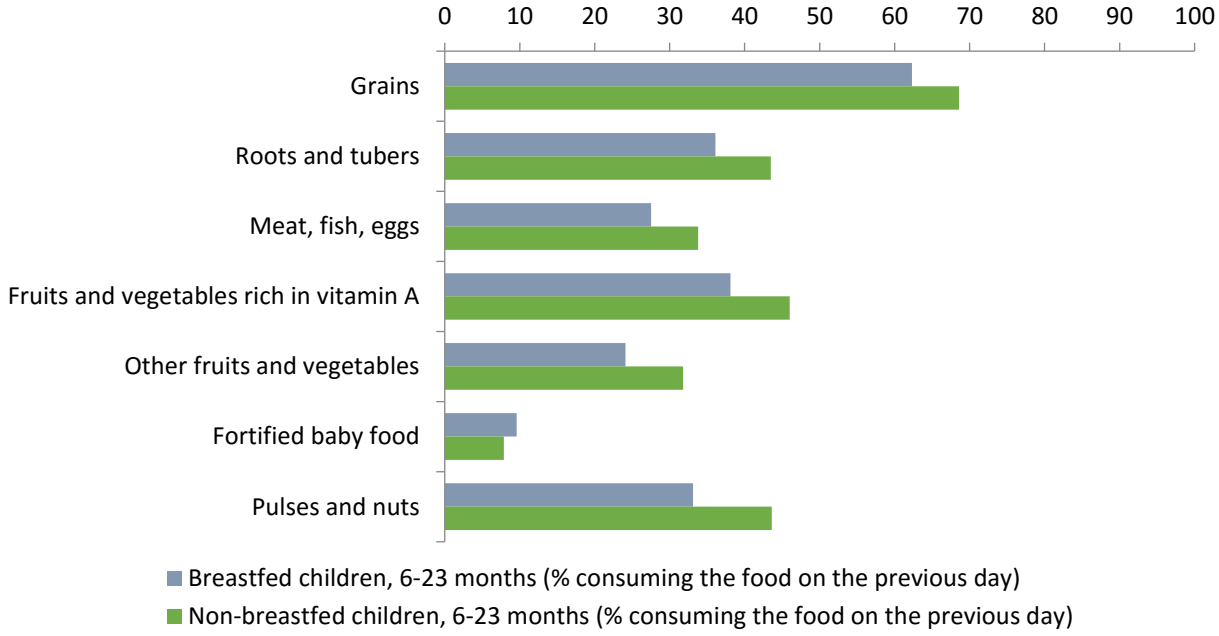
[3] Source: Food balance sheet for Benin, 2011, from FAOSTAT, accessed 20 October, 2016.

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




Source: Authors' presentation based on data from FAOSTAT, accessed 07 Oct 2016
Note: Based on their nutrient profiles, pulses and nuts include groundnuts and soybeans, although these foods are classified by FAO as oilcrops. Coconuts are not included among pulses and nuts because they have low protein content

**Figure 3: Percentage of infants and young children consuming foods from selected food groups (2011-12)**

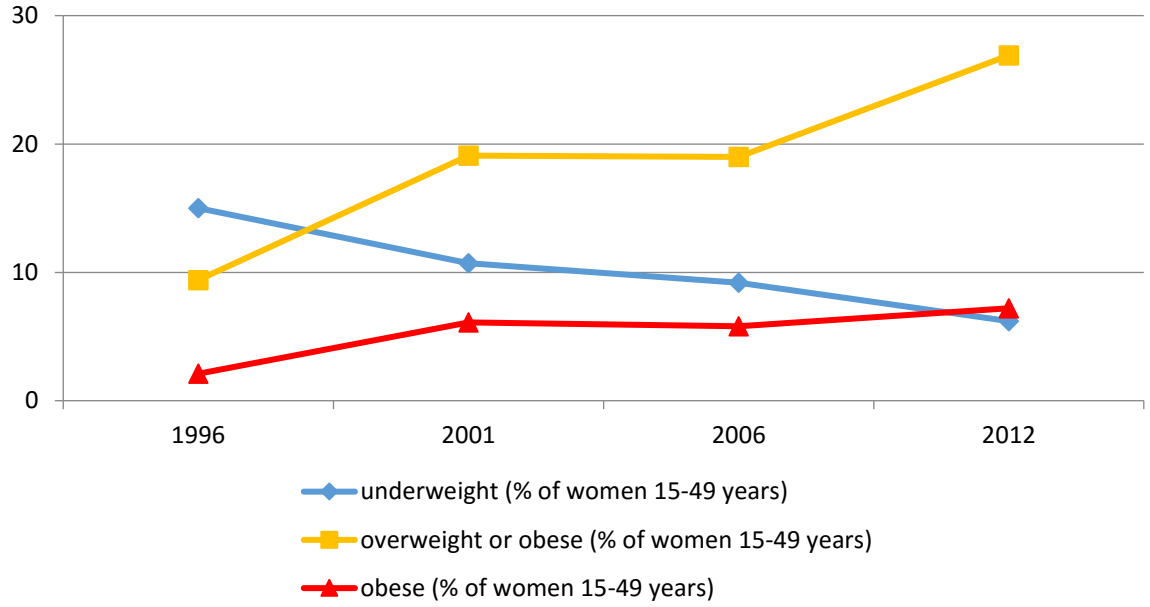



Source: Authors' presentation based on data from Institut National de la Statistique et de l'Analyse Économique and ICF International (2013)

Stunting and wasting are indicators of chronic and acute child undernutrition, respectively. In Benin, the prevalence of stunting is 34% and thus within the range for moderate public health significance (Table 3). There has been little progress on stunting since the mid-1990s: The proportion of stunted children fell by only 5 percentage points since 1996 (UNICEF[4]/WHO/World Bank, 2016). Wasting was reduced by almost two thirds in the same period and stands now at 4.5%, which means it is below the threshold for mild public health significance. According to the latest available data, overweight among children is low and no cause for concern at the present time (Table 3).

Overweight and obesity are risk factors of chronic diseases such as diabetes (Must and McKeown 2012). Nearly 30% of adults in Benin are overweight or obese (Table 3). According to data from the Demographic and Health Surveys (DHS), the combined prevalence of overweight and obesity among women of reproductive age has almost tripled since the mid-1990s, while the prevalence of obesity has more than tripled (Figure 4). At the same time, the prevalence of underweight has fallen to a relatively low rate of 6%.[5]

**Figure 4: Underweight, overweight and obesity among women of reproductive age (1996-2012)**




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

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 Benin, more than half of all children in this age group are estimated to be vitamin A deficient (Table 3). Close to 60% of children aged 6-59 months and about two fifths of all women of reproductive age suffer from anemia (Table 3). 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 in most West African countries, including Benin (University of Oxford, 2015).

Regionally disaggregated data are available for indicators of child feeding, anemia among children, and women's nutrition status. The diversity of infants' and young children's diets is particularly low in the Alibori region and highest in the Littoral region, which includes the capital city Cottonou (Table 4). The Littoral and Couffo regions do best on the shares of children consuming foods rich in vitamin A and

[4] UNICEF = United Nations International Children's Emergency Fund
[5] See Annex A for definitions of overweight, obesity, and underweight.

iron, whereas the Alibori region lags behind on both indicators. Only about one third of children are anemic in the Donga region, but the prevalence is more than twice as high in the Borgou, Atacora and Plateau regions (Table 5).

Regarding overweight and obesity among women, the Littoral region has the highest prevalence, and the Atacora region the lowest (Table 6). Underweight among women is least prevalent in the Donga region and is also relatively low in the Littoral and Borgou regions; however it is above the national average in the Mono, Atacora and Plateau regions. Anemia among women shows a similar discrepancy between the Donga region, which is at the low end, and the Plateau region, which is at the high end. Similar trends can be observed for anemia among children between these regions.

**Table 4: Child feeding practices by region, 2011-12**

| Share of children 6-23 months consuming: | | | | | |
|---|---|---|---|---|---|
| **4+ food groups** | | **Foods rich in vitamin A** | | **Foods rich in iron** | |
| **Region** | **(%)** | **Region** | **(%)** | **Region** | **(%)** |
| Littoral (Cotonou) | 50 | Couffo | 71 | Littoral (Cotonou) | 55 |
| Couffo | 42 | Littoral (Cotonou) | 66 | Couffo | 54 |
| Ouémé | 41 | Mono | 60 | Borgou | 48 |
| Mono | 35 | Ouémé | 59 | Ouémé | 48 |
| Borgou | 32 | Borgou | 57 | Donga | 39 |
| Donga | 29 | Donga | 56 | Collines | 36 |
| Atlantique | 28 | Atacora | 51 | Mono | 36 |
| Collines | 28 | Collines | 50 | Atlantique | 33 |
| Zou | 26 | Atlantique | 50 | Zou | 32 |
| Atacora | 24 | Plateau | 44 | Plateau | 30 |
| Plateau | 22 | Zou | 44 | Atacora | 29 |
| Alibori | 13 | Alibori | 30 | Alibori | 22 |

Source: Institut National de la Statistique et de l'Analyse Économique and ICF International (2013)
Notes: GIC regions are highlighted in red. See Annex A for definitions of the indicators.

**Table 5: Child nutrition status by region, 2011-12**

| Prevalence of anemia among children 6-59 months | |
|---|---|
| **Region** | **(%)** |
| Donga | 33 |
| Littoral (Cotonou) | 43 |
| Collines | 44 |
| Zou | 50 |
| Mono | 57 |
| Couffo | 59 |
| Atlantique | 59 |
| Alibori | 60 |
| Ouémé | 63 |
| Borgou | 67 |
| Atacora | 69 |
| Plateau | 86 |

Source: Institut National de la Statistique et de l'Analyse Économique and ICF International (2013)
Notes: Reliable and up-to-date data on stunting, wasting, and overweight in children by region are currently not available. GIC regions are highlighted in red. See Annex A for definitions of the indicators.

**Table 6: Women's nutrition status by region, 2011-12**

| Prevalence among women of reproductive age (15-49 years): | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Underweight** | | **Overweight + obesity** | | **Obesity** | | **Anemia** | |
| **Region** | **(%)** | **Region** | **(%)** | **Region** | **(%)** | **Region** | **(%)** |
| Donga | 3 | Atacora | 9 | Atacora | 1 | Donga | 21 |
| Littoral (Cotonou) | 4 | Donga | 14 | Donga | 3 | Alibori | 29 |
| Borgou | 4 | Couffo | 15 | Couffo | 3 | Collines | 32 |
| Alibori | 5 | Alibori | 19 | Alibori | 3 | Zou | 34 |
| Couffo | 6 | Borgou | 22 | Collines | 5 | Couffo | 36 |
| Collines | 6 | Plateau | 26 | Borgou | 6 | Mono | 38 |
| Ouémé | 6 | Zou | 27 | Zou | 6 | Littoral (Cotonou) | 41 |
| Zou | 7 | Collines | 29 | Plateau | 7 | Atacora | 42 |
| Atlantique | 7 | Atlantique | 29 | Atlantique | 7 | Borgou | 42 |
| Mono | 8 | Mono | 32 | Ouémé | 9 | Atlantique | 45 |
| Atacora | 8 | Ouémé | 33 | Mono | 12 | Ouémé | 47 |
| Plateau | 9 | Littoral (Cotonou) | 41 | Littoral (Cotonou) | 15 | Plateau | 76 |

Source: Institut National de la Statistique et de l'Analyse Économique and ICF International (2013)
Notes: GIC regions are highlighted in red. See Annex A for definitions of the indicators.

At the national level, anemia prevalence rates present the highest cause for concern out of all indicators of children's nutrition status (Table 3). Assuming that half of all anemia cases are due to iron deficiency, iron deficiency anemia among children has mild public health significance in the Donga region, severe public health significance in the Plateau region, and moderate significance in all other regions.[6]

Considering the indicators of women's nutrition status that are available for the regions, anemia has the highest prevalence rates in all regions except for the Littoral region where the combined prevalence of overweight and obesity is about the same (Table 6). Some regions, such as the Mono region, rank low on both underweight and obesity among women, which illustrates the double burden of malnutrition.

In summary, the high supply of carbohydrates in Benin as well as recent increases in overweight and obesity and persistent micronutrient deficiencies suggest that increasing the supply of non-staple foods should be favored over boosting the supply of starchy staples.[7] In order to diversify the diet, priority should be given to developing value chains for vegetables, fruits, animal-source foods, pulses and nuts, and possibly also to develop the value chain for red palm oil (rich in vitamin A). Pulses and nuts already play an important role in the Beninese diet and are good sources of protein and micronutrients. 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 beans

[6] About half of the global burden of anemia is attributable to iron deficiency (WHO, 2015b). Since the prevalence of anemia among children in Benin is in the range of 42.7-69.2% in all regions except for the Donga region (where it is lower) and in the Plateau region (where it is higher), the prevalence of iron deficiency anemia can be estimated to be 21.4-34.6% in 10 out of 12 regions and therefore falls within the range of 20-39% that has been defined to classify a moderate public health problem (see Annex A). However, it is possible that less than half of all anemia in Benin is caused by iron deficiency since malaria is widespread in the country.

[7] Raising agricultural productivity for cereals, roots and tubers may still be important to keep pace with population growth, raise incomes and alleviate poverty, and to reduce the currently high dependence on rice imports. If value chains for cassava are developed, the leaves should be given due attention, since they are a healthy, micronutrient-rich vegetable.

rich in iron and vitamin A-rich orange-fleshed sweet potatoes, yellow cassava and orange maize developed by HarvestPlus, also has the potential to improve micronutrient intakes.[8]

In addition, reducing the aflatoxin contamination of foods is critical to improve food safety in Benin. Aflatoxins are highly toxic substances that are produced by certain types of fungi and can cause acute poisoning, liver cancer, and stunted growth in children (Bhat and Vasanthi, 2003; Gong et al., 2004). In Benin, aflatoxin contamination of maize and groundnuts is a common problem, and dried vegetables from Benin and other West African countries were also found to be contaminated (Egal et al., 2005; Hell et al., 2009). Children in Togo and Benin experienced a marked increase in aflatoxin exposure when they were weaned onto solid foods, particularly maize. Blood samples of 479 children aged 9-59 months from four agro-ecological zones in the two countries revealed that 99% of the children had been exposed to aflatoxins in the last 2-3 months (Gong et al., 2003). The same cross-sectional study in Togo and Benin found a strong association between aflatoxin exposure and both stunting and underweight in children (Gong et al., 2002). A later, longitudinal study in Benin confirmed that aflatoxin exposure leads to impaired child growth (Gong et al., 2004). Benin is a member of the Scaling Up Nutrition[9] network, a global movement led by 57 countries that aims to end malnutrition in all its forms.

## 1.4 Data on most relevant crops and value chains

### *1.4.1 Production*

Table 7 presents the top 10 crops produced in Benin, taking into account the cultivated area and the volume produced. Data on the production value was not available at the time of writing.

**Table 7: Top 10 crops produced by area and volume**

| Area harvested (ha) | | Production volume (tons) | |
|---|---|---|---|
| **Top 10** | **Share of total** | **Top 10** | **Share of total** |
| Maize | 30.1 | Cassava | 33.7 |
| Cashew nuts, with shell | 17.9 | Yams | 26.0 |
| Seed cotton | 11.2 | Maize | 11.2 |
| Cassava | 8.4 | Oil, palm fruit | 4.9 |
| Yams | 6.5 | Pineapples | 3.0 |
| Groundnuts, with shell | 4.8 | Seed cotton | 2.7 |
| Beans, dry | 3.6 | Tomatoes | 2.5 |
| Sorghum | 2.8 | Rice, paddy | 1.9 |
| Soybeans | 2.8 | Cashew nuts, with shell | 1.6 |
| Rice, paddy | 2.2 | Cottonseed | 1.4 |
| | | Rank 16: Soybeans | 0.8 |

Data: average 2012-2014, FAOSTAT, accessed 16 January, 2017
Note: GIC value chains are marked in red, nes refers to Not elsewhere specified

### *1.4.2 Trade*

Rice is the most important import and export product in Benin. It accounts for more than half of the import volume and over 40% of the import value. The import of chicken meat accounts for 6.8% of the import volume and 14.2% of the import value. In export trade, poultry meat (turkey) accounts for a very insignificant amount in export volume and value. Goods that are based on soya also play a negligible role in Benin's trade.

[8] See www.harvestplus.org/what-we-do/crops.
[9] See www.scalingupnutrition.org/ for more information

**Table 8: Benin's imports**

| Import volume (tons) | | Import value (US$) | |
|---|---|---|---|
| **Top 10** | **Share of Total (%)** | **Top 10** | **Share of Total (%)** |
| Rice – total (milled equiv.) | 59.1 | Rice – total (milled equiv.) | 43.8 |
| Oil, palm | 7.6 | Meat, chicken | 14.2 |
| Meat, chicken | 6.8 | Meat, turkey | 8.2 |
| Sugar refined | 4.6 | Oil, Palm | 6.2 |
| Flour, wheat | 3.6 | Sugar refined | 4.2 |
| Meat, turkey | 3.6 | Flour, wheat | 3.0 |
| Wheat | 1.8 | Food prep nes | 2.4 |
| Food prep nes | 1.5 | Apples | 1.8 |
| Apples | 1.4 | Wheat | 1.0 |
| Tomatoes, paste | 1.0 | Crude materials | 1.0 |
| Rank 38: Cake, soybeans | 0.1 | Rank 51: Cake, soybeans | 0.0 |

Data: average 2011-2013, FAOSTAT, accessed 16 January, 2017
Note: GIC value chains are marked in red, nes refers to Not elsewhere specified

**Table 9: Benin's exports**

| Export volume (tons) | | Export value (US$) | |
|---|---|---|---|
| **Top 10** | **Share of Total (%)** | **Top 10** | **Share of Total (%)** |
| Cashew nuts, with shell | 26.2 | Cotton lint | 45.4 |
| Cotton lint | 24.3 | Cashew nuts, with shell | 22.5 |
| Oil, palm | 11.9 | Oil, palm | 14.0 |
| Rice – total (milled equiv.) | 9.1 | Sugar refined | 3.4 |
| Sugar refined | 7.1 | Sugar Raw Centrifugal | 1.7 |
| Cake, cottonseed | 4.8 | Oil, cottonseed | 1.7 |
| Maize | 2.3 | Cake, cottonseed | 1.4 |
| Sugar Raw Centrifugal | 2.2 | Rice – total (milled equiv.) | 1.3 |
| Flour, wheat | 1.7 | Oil, palm kernel | 1.1 |
| Food wastes | 1.5 | Maize | 1.0 |
| Rank 16: Cake, soybeans | 0.7 | Rank 13: Cake, soybeans | 0.5 |
| Rank 24: Soybeans | 0.1 | Rank 25: Oil, soybean | 0.1 |
| Rank 28: Oil, soybean | 0.1 | Rank 29: Soybeans | 0.1 |
| Rank 64 : Meat, turkey | 0.0 | Rank 58 : Meat, turkey | 0.0 |

Data: average 2011-2013, FAOSTAT, accessed 16 January, 2017
Note: GIC value chains are marked in red

## 1.5 National (and regional) innovation system

### *1.5.1 Research system and organizations*

Benin has a National Agricultural Research System (NARS) that ensures the development of technologies. The rules and regulations of the NARS were developed in a General Assembly in April 2004. It is coordinated by the National Institute of Agricultural Research of Benin (INRAB). The implementation policy and strategies of agricultural research are initiated and coordinated by INRAB, a public, scientific and technical structure with financial autonomy. The NARS is composed of the agricultural research centers of the national institute of agricultural research of Benin (INRAB), universities, private laboratories and research-based Non-Governmental Organizations (NGOs). The components of the NARS exploit the facilities of INRAB throughout the national territory and cover the different agro-ecological zones. Activities carried out in international research centers that are based in Benin are also taken into account in the development and coordination of scientific knowledge and technological innovations.

The generation of agricultural technologies supported by the program "Support to Agricultural Research" is done through protocols that deal with varied crops and domains. However, the accompanying mechanisms and measures to ensure the adoption of the developed technological innovations in the farmers' fields are one of the weaknesses of the system. The NARS does not have consolidated financial resources for its functioning and agricultural research still remains largely dependent on external funding.

**Table 10: Major actors of the agricultural research system in Benin**

| Type | Organization | Research Focus |
|---|---|---|
| **International** | | |
| | The United Nations Food and Agriculture Organization (FAO) | |
| | International Development Agency | |
| | French Agency for Development | |
| | Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) | Crops, livestock, food and energy security, public policy |
| | International Institute of Tropical Agriculture (IITA) | Crops |
| | Biodiversity International | Agricultural and tree biodiversity |
| | Africa Rice Center (AfricaRice) | Rice |
| **Regional** | | |
| | Forum for Agricultural Research in Africa (FARA) | Agricultural Research |
| | Africa Rice Center | Agricultural Research |
| | West African Economic and Monetary Union | Agricultural Research |
| | West and Central Council for Agricultural Research And Development | Agricultural Research |
| | West Africa Agricultural Productivity Program | Agricultural Research |
| **National** | | |
| | Institut National des Recherches Agricoles du Bénin | Crops, livestock, off-farm post-harvest, natural resources, socioeconomics |
| | Beninese Center for Scientific and technic research | Scientific and technic research |
| | Faculté des Sciences Agronomiques, Université d'Abomey-Calavi (FSA/UAC) | Pastures and forages, forestry, off-farm post-harvest, fisheries, agricultural engineering, natural resources, socioeconomics |
| | Laboratoire d'Étude des Climats, des Ressources en Eau et de la Dynamique des Écosystèmes, UAC | Natural resources, climate change |
| | Laboratoire de Génétique et des Biotechnologies, UAC | Crops |
| | Faculté d'Agronomie, Université de Parakou (FA/UP), | Crops, forestry, pastures and forages, off-farm post-harvest, socioeconomics. |
| | École Polytechnique d'Abomey-Calavi, UAC | Livestock, pastures and forages, fisheries |
| | Laboratoire de Biologie et de Typage Moléculaire en Microbiologie | Crops |
| | Ecole Nationale Supérieure des Sciences et Techniques Agronomiques de Kétou, Ecole Nationale des Sciences et Techniques de Conservation et de Transformation des Produits Agricoles de Sakété | Crops, forestry, livestock, off-farm post-harvest, pastures and forages, fisheries, natural resources, agricultural engineering, socioeconomics. |
| | Réseau de Développement d'Agriculture Durable | Crops |
| | Groupe d'Action et de Recherche pour le Développement Communautaire | Livestock, pastures and forages, off-farm post-harvest |
| | Centre Béninois pour l'Environnement et le Développement Economique et Social | Socioeconomics, natural resources |
| | Groupe de Recherche et d'Action pour l'Auto-Promotion rurale | Socioeconomics |

Data source: adapted from Zoffoun, 2014a.

### *1.5.2 Innovation platforms*

In Benin, MSPs are being used to manage research and innovation transfer in the agricultural sector. The positive effects of MSPs in Benin include the adoption of new rice varieties, production techniques, and better access to inputs and market opportunities (Adegbola *et. al.,* 2016).

Several innovation platforms have been initiated, and some of these platforms are presented below (Adegbola *et. al.,* 2016):

- A Varietal Innovation Platform (VIP) has been put in place as part of the "Participatory Varietal Evaluation of Plantains" project. Two VIPs have been created in the big plantain producing zones in Benin (Tori-Bossito and Zè). These VIPs involve research organizations (INRAB) and extension (CeRPA, the regional center for agricultural promotion), producers' organizations, producers, processors, etc. and one development NGO;
- The National Platform for Innovation in the Agricultural Sector in Benin (PNISA) aims at achieving the vision of the agricultural sector and contributing to poverty reduction through a synergy of competences of innovation actors in the agricultural sector. PNISA brings together all entities of the public and private sectors operating in the agricultural and agro-industrial fields in Benin. Various actions have been undertaken, the most important being the facilitation of multi-actors project development in the rice and pig sectors;
- In the implementation of the Convergence of Sciences programme, MSPs have been used in participatory knowledge-building in order to better manage the proliferation of two strong and damaging weed species in Damè-Wogon (Commune of Bonou) and Somè (Commune of Za-Kpota). MSPs are composed of producers, extension agents, scientists, NGOs and local decision-makers. The programme has built synergies between several disciplines (social and biological sciences) and between modern and traditional sciences. It has also contributed to building producers' capacities (human capital) in seeking solutions to agricultural problems and the organizational capacity of producers (social capital);
- Farmer Field Fora (FFF) is a capacity building mechanism that supports decision making based on the agro-ecosystem analysis. The ultimate goal being to develop sustainable exchange platforms between producers, scientists and extension agents. The development of the FFF under the cowpea project for Africa at the International Institute of Tropical Agriculture (IITA) made it possible to enhance integrated management, agro-ecosystem-based decision-making by producers, the spontaneous networking of trained producers, the effectiveness of producer-to-producer training, the promotion of endogenous innovations and the replication of acquired knowledge to other crops by producers;
- As part of the implementation of the lowland agricultural identification project, two MSPs were established in two villages. The MSPs were composed of internal actors (direct users of lowlands; producers, consumers), external actors (research and support structures including INRAB, IITA, CIRAD, International Center for Development Oriented Research in Agriculture, FSA, AfricaRice, CeRPA, Groupe de Recherche et d'Action pour le Développement Intégré et Durable, etc.) and local and religious authorities. The establishment of these platforms has allowed actors to have an exchange framework for the cultivation of lowlands and to participate fully in research and development (R&D) activities. The success observed in these villages has aroused interest in the adoption of the MSP approach in the other villages;
- In the implementation of the research project "Realizing the agricultural potential of the inland valley systems while maintaining their environmental services in sub-Saharan Africa", capacity-building MSPs were used to ensure coherence of activities and linkages between the components in Agbédranffo / Vovokanmey (Dogbo) in Houinga-Houégbé (Houéyogbé). These MSPs were composed of land owners, agricultural producers, animal breeders, fish farmers, traders,

processors, transporters; processors, NGOs, Town councils; research (INRAB); and extension. This approach has had convincing results in terms of sustainable lowland value addition;

- The Syprobio project is also using innovation platforms to test innovations in cotton producing systems in Benin. The innovation platforms have helped producers to gain confidence in personal organization process as well as in research.

### *1.5.3 Extension system and organizations*

In Benin, technology and innovation transfer is ensured by the National Agricultural Research and Extension Systems (NARES). The NARES was created in 1992 with the advent of the Project to Restructure Agricultural Services. It is composed of private and public extension structures, agricultural professional organizations and agricultural research. The functions of the NARES, defined in administrative acts, include the identification of producers' concerns, the search for solutions (to take into account existing innovations or encourage research activities on constraints that are not yet covered) and technology transfer.

The following organizations and universities provide extension services in Benin.

- Ministry of Agriculture, Animal Husbandry and Fisheries (MAEP):
  - Department of Agricultural Council and Operational Training (DICAF);
  - Central Region for Agricultural Promotion (CeRPA) formally known as Regional Action Center for Rural Development (CARDER).
- Public Research and Extension Institutions:
  - INRAB;
  - Agricultural Research and Training Center.
- University Extension Services: FSA/UAC; FA/UP.

Private extension service provision is not common.

### *1.5.4 Private research and development activities*

In Benin, very few development research activities are carried out by the private sector. However, private operators who supply inputs and gin cotton are key actors in the innovation processes. Their active involvement in the generation and dissemination of innovations has improved the types of public-private partnerships promoted by the PSRSA and all other agricultural development strategic documents. Through the "Grow Africa Partnership", several private actors are now investing in the agricultural sector in Benin. Among these private companies include Nad & Co Industry, Orabank, Pepite d'Or, Royal Fish, Société des Huileries de Bohicon, Sotracom, etc.

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

The challenges in Benin's agricultural sector include:

- Degradation of land and water resources;
- Land insecurity mainly in the south of the country;
- Degradation of roads;
- Very low involvement of smallholder farmers in the decision making process;
- Volatility of international prices of key agricultural products such as cotton and palm oil;
- Competition (in quality and price) of imported products such as Asian rice with local products;
- Rapid deforestation and desertification;
- Climate change and aggravation of technical constraints in the production systems through the modification of rainfall regimes and the weak capacity of family farmers;
- Limited access to rural credits for the implementation of production activities;

- Malnutrition and lack of infrastructures (transport, storage, processing, etc.);
- Low funding of research and transfer of agricultural innovations.

## 1.7 Potential areas for investment in Benin

Based on the general approach presented in chapter 4 of Husmann et al (2015) and in pursuit of efficiency and effectiveness, investment by Germany into the agricultural and food sector are suggested in those 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 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 Benin[10]**

Expected agricultural growth performance:

- Benin has had a rate of agricultural growth higher than the 6% target defined by CAADP for only two years in the period of 2005-2014.
- However, Total Factor Productivity (TFP) in Benin has improved by 11 percentage points between 2001 and 2008.

Government commitment:

- Benin has a track record of political commitment to foster sustainable agricultural growth by being active in the CAADP process and having completed all the eight steps in the CAADP process;
- However, Benin had not shown any willingness to invest in the agricultural sector. In no single year has the government invested more than 10% of total government expenditures (CAADP target) in the agricultural sector between 2005 and 2014;
- Benin had also spent only 0.5% of its agricultural GDP on agricultural R&D, which is much lower than the Sub-Saharan Africa average and the AU R&D investment target value of 1%. This indicates that Benin´s investment on agricultural innovation is not yet sufficient.

Food and nutrition security progress and need:

- Benin is prioritizing actions for hunger and malnutrition reduction and has shown an improvement by more than 10 percentage points in undernourishment between 2001 and 2011;
- Still, Benin has a Global Hunger Index (GHI) score value of 11.2, reflecting a serious level of hunger[11]. This justifies the investment into the agricultural and food sectors in Benin in order to fight the high levels of food insecurity;
- However, the overall economic, political, and social/nutrition framework in Benin does not appear to be ready for accelerated investments into the agricultural and food sector of the country. It is therefore questionable whether Benin should be a priority country for German investments.

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

**Table 11: Benin performance indicators**

| Indicator | Indicator score | Overall score |
|---|---|---|
| 1. Number of years with more than 6% agricultural growth (2005 to 2014) | 2 | 20 |
| 2. Percentage point change in TFP index between 2001 and 2008 | 11 | 60 |
| 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 % | 0.5 | 53 |
| 5. Steps in CAADP completed | 8 | 100 |
| 6. Percentage point improvement in undernourishment between 2001 and 2011 | 11 | 100 |
| 7. Global Hunger Index (2014) | 11.2 | 0 |
| Total score (weighted) | | 47 |

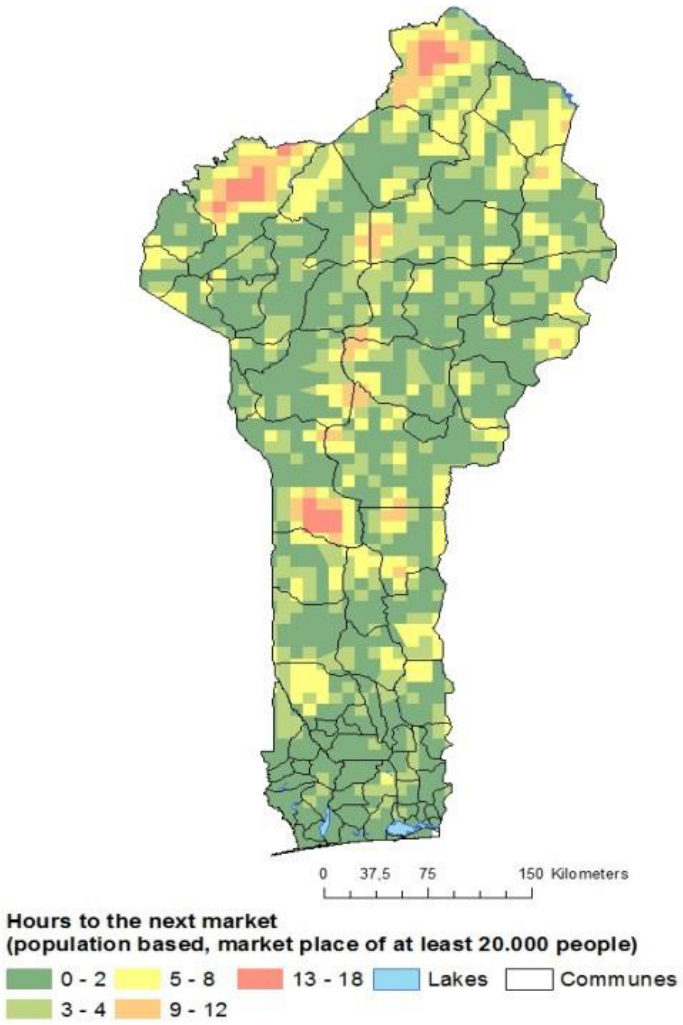
Data source: Husmann et al (2015)
Note: TFP refers to Total Factor Productivity

Nonetheless, there are a number of indicators of potential in Benin's agricultural sector:

- Benin has sufficient farm lands, of which only 17% are currently cultivated;
- Benin has 322,000 ha of favorable land with potential for rice production, of which only 33,294 ha is currently in use;
- There exists accompanying structures (projects and NGOs) for the development of priority sectors, including rice;
- The tropical climate is favorable to several crops that can be commercialized on national markets as well as on regional and international markets;
- Several qualified pioneers are emerging, who can increase the level of agricultural production and serve as examples for others, particularly the youth;
- Food demand is increasing in the national market;
- The government is willing to modernize agriculture through the development of several inlands valleys and the implementation of several supporting programs and projects;
- There exists a National Agricultural Research System.

The selection of the value chain on which to focus on is also determined by market access, that is, transport intensive products should be promoted in areas that are well connected to markets, whereas the 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 Benin.

**Figure 5: Distance to markets**




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

# 2 Most relevant value chains in Benin

## 2.1 GIC- value chains

### *2.1.1 Rice*

Rice paddies make up only 2% of the total harvesting area of Benin and 2% of total production volume (see Table 7). Rice is the most important domestic calorie source, providing about 530 kcal per capita per day. Rice makes up over 43% of Benin's imports (in value) and 1.3% of its exports (in value) (see Tables 8 and 9). Benin has a clear comparative disadvantage in rice, with a Revealed Comparative Advantage (RCA) index of only 0.01 (see Table 12).

Rice is a significant food item in Benin (15-20 kg of milled rice per capita per year). Benin has significant potential for rice promotion in terms of irrigable lands, ground and surface water resources, and proven technologies, which have been developed through research. Through its national rice development strategy, Benin plans to achieve production of at least 385,000 tons per year to meet the needs of the population, and export the surplus by the year 2018. However, there are huge constraints that limit the development of the rice sector. The constraints include biotic and abiotic stresses, lack of adapted credits, lack of adapted working materials and equipment, and lack of specific quality inputs.

Local rice faces a number of market constraints, such as the non-availability of the product throughout the year and the less attractive quality-price ratio. Furthermore, the average quality of rice produced locally is very poor (often 30 to 35% consists of broken rice). To achieve better performance and make the rice sector competitive, the country needs to: (i) adopt rice varieties that are better adapted to local conditions, (ii) facilitate access to good quality inputs, (iii) support producers in developing rice producing sites, (iv) create the required post-harvest conditions to ensure greater presence of better quality local rice on the markets.

### *2.1.2 Soya*

Introduced in Benin in the 1945s, soya has started to gain importance, with the increasing demand from mills that substitute cotton seeds for soya, and the sub-regional market. Soya makes up only 2.8% of the total harvesting area of Benin and 0.8% of the total production volume (see Table 7). Benin hardly imports soya (it ranks 38 in terms of import volume and 51 in terms of import value [see Tables 8 and 9]). Benin has a clear comparative disadvantage in soya, with a RCA index of only 0.01 (see Table 12), but it is of great relevance to the country, as it constitutes a bigger proportion of total supply.

Improved seeds are the major input in soya production. Some seed varieties have a potential yield of about 2 to 3 tons/ha. Dissemination of good soya cultivation practices by research institutions has resulted in an increase in yield from 700 to 900 kg/ha, but access to seeds remains a major constraint. Soya seed distribution is overseen by structures that are not very competent. There is no seed multiplication structure, resulting in limited supply of seeds.

Throughout the country, soya producers' organizations are at a nascent stage. At the level of the producing communities, there are producers' unions without formal representation on the ground. The key soya commercialization actors are producers' organizations who initiate collective marketing. There are also collectors who buy products at the farm gate and traders maintaining an important network of middlemen, oil mills, processing units, feed mills and animal breeders. Regarding processors, there are two categories: (1) enterprises, which are oil mills, roasted soya processing or soya-based flour units, feed mills, etc., that process and market their products and (2) women processors who practice artisanal soya processing.

### *2.1.3 Poultry*

Animal production is still dominated by traditional animal husbandry of goats and poultry, despite the quite positive results of modern animal husbandry projects over the last decade. The number of farm animals is estimated to be 2,216,000 small ruminants and 14,500,000 poultry in 2007. Concerning local poultry farming-based value chains, they do not have a significant impact on Benin's trade balance because there is no import or export of consumable eggs. The commercialization of living poultry (traditional poultry farming products) from collection, wholesalers to retailers is predominantly performed by women, with some men who are more active in collecting animals.

## 2.2 Other relevant value chains

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

### *2.2.1 Cassava*

Cassava has been cultivated in Benin since the 1840s, during the reign of King Guézo. Cassava is essentially produced for local consumption and contributes to food security and nutrition in the country. It makes up only 8.4% of the total harvesting area of Benin and is the leading crop produced in terms of volume: 33.7% of total production volume (see Table 7). Average production of cassava in the past 20 years reached over 2,666,000 tons with about 85% of output coming from the South and the Center regions. Farm sizes vary according to smallholders' living conditions and resources. The smaller farms are between 0.5 and 3 ha in size, while large cassava domains are between 5 and over 10 ha in size. Per capita annual consumption varies by region, with 104 kg for the South, 94 kg for the Zou, 42 kg for Borgou and 17kg for Atacora (ONASA and DAPS/MDR[12] statistics, 1990s). Several parts of the cassava plant are used; the leaves and tubers are used in local dishes, and products such as flour, starch, gari, tapioca, chips, food and medical alcohol are derived from the crop (FAO and IFAD, 2005).

### *2.2.2 Yam*

Benin is fourth largest yam producing country in West Africa. Yam, along with cassava, constitutes an important staple crop for local populations with 55% of which depends on yams for food and income security. Average per capita consumption of yam is more than 400 kcal a day (FAOSTAT, 2017) Average production over the last 20 years was almost 2,036,000 tons. However, productivity has been declining due to biotic (pests and diseases), natural and manmade (climate change, soil degradation) constraints (Affokpon, 2014). The main farming zones include the North and Center regions of the country.

### *2.2.3 Maize*

Maize is the most consumed cereal in Benin, and it is highly important for food security in the country. Maize takes up to 30% of the harvesting area and is the third crop in terms of quantity produced, which is 11.2% of total agricultural production by volume (see Table 7). However, there is a high variability in maize output, posing a serious threat to food security and the revenues of producers. In addition to climate variability and the cyclical phenomenon of drops in sales for this product, this situation can be explained by the non-availability of specific fertilizers in a context of constant land degradation and low availability of good quality seeds. Furthermore, post-harvest losses (fluctuating between 30 and 40%) and exports of the national production to neighboring countries are contributing factors. Moreover, the specific needs of maize utilizers (breweries, sweet corn/legume, fodder, etc.) are not yet covered by local production. It is therefore urgent to take specific actions in the maize sector in order to improve its contribution to food security and to producers' revenues.

### *2.2.4 Cotton*

Cotton is an important cash crop for the country. In the 1980s, the sector contributed to more than 10% of GDP. The creation in 1981 of the government-owned cotton company allowed the government to have a monopoly on the purchase of cotton seed, the sale of cotton lint and the delivery, on credit, of cotton inputs to farmers. However, the sector was liberalized in the 1990s through a privatization

[12] ONASA = Office national d'appui à la sécurité alimentaire ; DAPS/MDR = Direction de l'Analyse, de la Prévision et de la Synthèse du Ministère du Développement Rural

process. These reforms had severe impacts on the sector and resulted in a sharp decline in performance. Nonetheless, cotton still constitutes the first export crop with 45.4% of total export value earned from cotton lint (see Table 9). The sector directly benefits more than 300,000 farmers and provides livelihood and revenue to around 3 million people. It is the only cash crop produced in the north of the country (Gergely, 2009).

### *2.2.5 Oil palm*

Historically, oil palm occupied an important place in Benin. Its cultivation further developed during the reign of King Ghézo in the 1800s. Demand from Western countries for palm oil increased in order to supply their soap manufacturing industry. Thus, palm plantations were organized. Subsequently, trade in palm products grew considerably during the second half of the nineteenth century with a "golden age" during the 1930s. However, those natural palm plantations, which represent 60 to 70% of the planted areas, have steadily decreased from 500,000 ha to less than 300,000 ha nowadays. Due to aging trees and plant materials, yields are low, 2 to 3 tons/ha, with an extraction rate of only 6%. More recent plantations such as small farmer and industrial plantations are estimated at 3,000 ha and 11,000 ha respectively, with a potential yield of 12 tons/ha and a 24% extraction rate (small farmer productions). The average production of oil palm was almost 308,000 tons for the past 20 years, and the crop is the third largest export, representing 14% of total export value (see Table 9) (MAEP, 2012).

### *2.2.6 Pineapple*

Although appreciated on the European market for its color (golden yellow) and its taste, Benin supplies only 0.24% of the pineapple exported to the European market. The varieties of pineapple cultivated are the *Cayenne Lisse* and the *Pain de sucre*. Pineapple production zones are located in Southern Benin. According to FAOSTAT 2014, national pineapple production is increasing. There is an increase in the harvested areas and production, while yields are decreasing. The post-harvest sector is confronted with a multitude of constraints thereby lowering the export performance of this commodity. Exports are organized individually, and the sector does not enjoy effective support from the government.

The European market is the main outlet for a limited number of big producers in Benin. A great share of their production (about 80%) is intended for this market. However, to have the tonnage required to export, they buy from the other producers. Five value-adding chains in the pineapple sector in Benin have been identified: fresh pineapple for the European market, fresh pineapple for local market, fresh pineapple for the sub-regional market, pineapple juice and syrup for local and sub-regional market and dried pineapple for local, regional and European markets. The different value chains are categorized based on the type of product, the intervening actors and the destination.

### *2.2.7 Cashew nut*

Cashew nut is the second most important export crop in Benin after cotton and represents 22.5% of total export value (see Table 9). With a production area covering six out of the twelve departments of the country, the crop is becoming more important socio-economically and environmentally. The interest of farmers and other operators for cashew cultivation during the past years has resulted in an increase in the cultivated areas of cashew plantations (from 165,000 ha in 1998 to 191,000 ha in 2007). Exports of Benin's raw cashew nuts to the international market (China, Indonesia, Vietnam, European Union, etc.) have increased a lot these last years, from 19,174 tons in 1997 to 69,357 tons in 2006. This increase in Benin cashew exports penetrating the international market, coupled with an improvement of producers' and other actors' margin, has made cashew a strategic crop with promising development perspectives. Despite the many advantages of the cashew sector, several constraints still hinder its development, particularly the low yield of varieties used. Ongoing research activities on varietal improvement should be continued. Other constraints include low availability of pesticides and non-utilization of fertilizers. Addressing these constraints will promote cashew nut in the country's

agricultural exports and make this crop a means of revenue diversification for producers at the local and national level.

## 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 12 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 12: Selection of the most promising agricultural product /value chain**

| | **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** | Cashew nuts, with shell | 114 | Chillies and peppers, green | 14 | Cottonseed | 121 |
| **2** | Cake, cottonseed | 16 | Cashew nuts, with shell | 7 | Maize and products | 104 |
| **3** | Oil, palm | 3 | Sweet potatoes | 6 | Nuts and products | 101 |
| **4** | Sugar refined | 2 | Vegetables, fresh | 5 | Millet and products | 100 |
| **5** | Pineapples | 1 | Rice, paddy | 5 | Soybeans | 100 |
| **GIC Value chains** | Rice | 0.01 | Soybeans | 6 | Rice | 24 |
| | Soybean oil | 0.01 | | | Poultry meat | 13 |

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 12):

- The trade potential (RCA index), is very high for cashew nuts, cottons, palm oil, refined sugar and pineapples. This indicates that Benin has comparative advantage (in the export) of these

commodities. The RCA value for the GIC crops is less than 1 indicating that Benin has comparative disadvantage in the export of rice and soybean (selected by the GIC);

- The yield performance indicating progress suggests that over the CAADP period (2005 to 2012), chilies, cashew nuts, sweet potatoes, vegetables and the GIC value chains are the five most promising crops. The other GIC selected crop, soybean, is also growing at a relatively higher rate, 6%, though its production volume share is less than 0.5%;
- In terms of relevance (production share of supply) cottonseed, maize and products, nuts and products, millet and products, and the GIC soybean crop are leading. The production quantity of the first three products exceeds the total demand, and the latter two are also fully produced in the country. On the other hand, about a quarter of the total supply of rice (GIC value chain) and slightly about a tenth of the other GIC crop, poultry meat, is domestically produced.

### 2.4 Summary on selection of agricultural products and value chains

This chapter (chapter 2) has presented different relevant and important value chains in Benin based on different criteria – resulting in different value chains. In summary, the three top value chains – GIC selected value chains, other relevant value chains, and those identified by the analysis of promising agricultural products and value chains – are presented in Table 13. The summary table shows that none of the GIC-selected value chains correspond to those identified by review of literature and by the analysis of promising agricultural products and value chains. However, a number of overlaps in the value chains exist between the analysis of promising agricultural products and value chains and the literature. These products/value chains are cashew nuts, cotton, maize, and oil palm.

**Table 13: 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 |
| Rice | Cassava, Yam, Cashew | Cashew nuts, with shell | Chillies & peppers, green | Cottonseed |
| Soy | Maize, Oil palm | Cake, cottonseed | Cashew nuts, with shell | Maize & products |
| Meat (poultry) | Cotton seed, Pineapple | Oil, palm | Sweet potatoes | Nuts & products |

Source: Authors' compilation

# 3 Innovations in value chains in the past 20 years

### 3.1 Main limiting factors

The challenges related to the production of rice in Benin include irrigation, farmer organizations, access to credit, technology adoption, and competition. The lack of effective rules for water sharing and improper canal maintenance in the irrigated rice valleys negatively affect the use of water and therefore negatively impact output and farmers' revenues. Also, power relations and struggles often exist within farmers' associations, hindering trust, collective action and equal access to resources. Market liberalization policies also created competition from imported rice in local markets, which led local farmers to increasingly rely on local traders that now have higher bargaining power. Furthermore, farmers are still subject to rent seeking local creditors despite having access to credit from local banks.

All these local and national institutional barriers ultimately lead to a low rate of technology adoption, namely high-yielding varieties and irrigation technologies, by rice farmers (Totin et al., 2012).

In terms of animal production, most of the projects that allowed the promotion of the value chain (Projet de Développement de l'Elevage Borgou Est, Projet d'appui au Développement de l'Elevage dans le Borgou, etc.) through support for income generating activities, training, information, animal health, etc., have ended with no obvious carry-on prospects. One of the constraints in the animal value chain is the insufficient provision of veterinary services. Current efforts focus on supporting modern and traditional poultry farming and the rearing of small ruminants and initiatives for dairy production. The preservation of the genetic heritage managed by various state farms also remains an issue. However, efforts have been made towards the prevention of and emergency responses to animal diseases such as bird flu through the projects to support the prevention and fight against avian influenza (Conseil des investisseurs privés du Bénin, 2007).

For the soybean value chain, Sewade (2016) argues that access to certified quality seed is the main factor limiting the extension of the value chain. There are also several other elements that explain this situation. Storage conditions of soybean seeds in rural areas do not allow the seeds to preserve their germination properties. Furthermore, the use of seeds bought in markets or from previous harvests does not provide yields that exceed 500kg/ha, and the mixing of varieties does not provide the expected yields of pure cultivars (Sewade, 2016).

Cross-cutting limiting factors include:

Very low funding from the Government to research organizations

- NARS does not have consolidated financial resources to operate, and agricultural research still depends largely on external funding. The Management Cycle of Agricultural Research and its mechanism of competitive funding are not enough to fund research projects of the entities;
- There is almost no involvement of private enterprises in the research-development activities, contrary to what is done in other nations, where these private operators allocate an important part of their budgets to research;
- There is a lack of human resources due to movements to other organizations and the prevalence of the non-replacement policy;
- Inadequacy of logistics, laboratory materials, energy and water.

Weakness of technology innovation transfer systems

- The low rate of adoption of technological innovations has always been one of the major characteristics of family farming;
- Limited access to information on technological innovations;
- Difficulty in strengthening the public-private partnerships to help clients obtain the information they want from the public sector;
- Limited required resources for the provision of good extension services;
- Weak capacity and lack of knowledge of new technologies;
- Poor linkages between research institutions and producers' and processors' groups.

## 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 Benin in the last 20 years. The described innovations are considered significant or beneficial

because of widespread adoption, proven positive impact on increasing productivity, increasing incomes, adapting to the environmental challenges (such as drought), creating employment etc.

### *3.2.1 GIC value chains*

Some examples of important and beneficial innovations in the GIC value chains include:

- Rice value chain: rice thresher, rice grading machine, rice milling machine for rice
- Soya value chain: dried soy flour, soya cheese production, soya yoghurt production
- Pineapple value chain: production of pineapple jam, jelly, powder and pineapple-based alcohol, wine, vinegar
- cashew value chain: improved cashew nut peeler, powered cashew nut grinder, cashew fruit harvesting net, cashew juice with gelatin, and cashew nut flour of dried cashew

**Table 14: Innovations in the rice value chain**

| Innovation | | |
|---|---|---|
| **Production** | **Harvest** | **Post-harvest** |
| Technical itinerary of rain-fed and low-land rice production | Paddy rice thresher-cleaner | Improved paddy rice parboiling device |
| Tracer and marker for rice sowing | Pedal paddy rice thresher | High capacity improved paddy rice parboiling device |
| Power tiller for puddling in the low-lands for rice cropping | Powered paddy rice thresher | Improved paddy rice drying process |
| Row weeder | Mechanical paddy rice cleaner | Improved paddy rice parboiling process |
| Rowling rice seeder | Manual rice grading machine | Rice straw-based feed for ruminants |
| NERICA, BERIS 21, IRAT127, BL19, andIR841 rice varieties, performing and adapted to parboiling | Powered rice grading machine | Rice bran-based feed for cattle |
| Azolla organic fertilizers and herbicide | Mechanical rice milling machine | Rice-based combustible briquettes |
| Digging of cased wells | | Production of cakes, biscuits, etc. from NERICA |

Source: Adegbola *et al.* (2016)

**Table 15: Innovations in the soya value chain**

| **Production** | **Transformation** |
|---|---|
| Inoculation of soya to improve its agronomic performances | Very nutritious dried soya flour technologies, especially for children |
| Improved production technique | Soya yogurt production |
| Leaves and other parts of the plant are transformed into organic fertilizers | Soya cheese production highly appreciated by Benin population and consumed all over the country |
| | Soya biscuit production |

Source: Adegbola *et al.* (2016)

**Table 16: Innovations in the pineapple value chain**

| Production | Transformation |
|---|---|
| Good practices of pineapple production for fresh export | Improved techniques for drying biological pineapple |
| Pineapple cultural practices | Production of natural pineapple juice |
| Techniques for pineapple rapid shoot production | Production of pineapple jam |
| Pineapple cultivation (multiplication and packaging of shoots) | Production of pineapple jelly |
| Techniques and procedures of compost production from pineapple by-products | Production of canned pineapple pulp |
| | Production of pineapple powder |
| | Production of pineapple-based alcohol, wine, vinegar |

Source: Adegbola *et al.* (2016)

**Table 17: Innovations in the cashew nut value chain**

| Production | Harvest | Post-harvest |
|---|---|---|
| Grafting cashew plants using lateral cleft grafting | Improved cashew nut peeler | Preparation of cashew-based pella cake with cereals |
| Grafting cashew plants using chip budding | Mold cashew nut peeler | Cashew apple delight |
| Top grafting of nonproductive cashew plants | Pliers cashew nut peeler | Cashew apple delight |
| Good practice of cashew plantation management | Powered cashew nut grinder | Cashew juice press |
| Rehabilitation of old cashew plantations | Cashew nut harvesting basket | Cashew-based table wine |
| Production of quality cashew seeds | Cashew fruit harvesting net | Cashew-based jelly |
| Production of quality cashew plants | Cashew fruit harvesting tarpaulin | Cashew juice and cassava starch |
| Direct seeding of cashew nuts | | Cashew juice with rice meal |
| | | Cashew juice with gelatin |
| | | Flour of dried cashew |

Source: Adegbola *et al.* (2016)

### *3.2.2 Other value chains and cross-cutting innovations*

Poultry and ruminant innovations:

- Improved technology for poultry castration;
- Genetic improvement of the Djalonke breed;
- Yam bean flakes in the feed of small ruminants;
- Improved technologies in the feed of small ruminants and poultry;
- Fish culture innovations;
- Reproduction of black cat fish (*Clarias gariepinus*) by injection of hormones;
- Mullet farming in pond;
- Off-soil farming of aquatic species;
- Ground farming of aquatic species, etc.

# 4 Suggestions for Collaboration

Collaboration between Germany and Benin in agricultural R&D dates back to several decades. The different partnerships between these two nations cover several sub-sectors within which several technologies and other convincing results can be observed. Agricultural research lies today at the heart of all agricultural issues and is targeted by all national and international initiatives as an indispensable pillar for economic growth in Africa.

It is therefore important to look into the effective utilization of approaches, such as MSPs, in order to develop sustainable innovations and ensure their adoption by the target groups. Innovation-system approach more of a supplementary process that can convert research result into development products, and a systematic follow-up of supply chains with high demand by the ultimate beneficiaries.

Throughout this document, we have presented the characteristics of Benin's agricultural sector, and particularly those of Benin's National Agricultural Research System (NARS). The partnership should support the implementation of innovations in order to:

- Remove the constraints to the development of the key sectors retained by the PSRSA;
- Identify other profitable sectors and ensure their development;
- Investigate and develop relevant adaptation strategies of human and natural systems to climate changes
- Support and build the capacities of family farmers in order to meet key issues and climate challenges.

The extension efforts for wide scale dissemination and adoption of improved technologies, which were developed by research, should be intensified. This objective can be promoted by boosting a group of actors, including producers, scientists and extension agents of the public (CARDER) and private (NGO) sectors, based on an interactive participatory model, which would ensure the monitoring of the adoption and an analysis of conditions and factors. Integrating technologies that have proven technical and economic efficiency for cropping and production systems will create a productive impact in terms of increasing the quantity, quality and sustainability of production, as well adding economic value by improving the living conditions and well-being of the producers (Adegbola et. al., 2016).

Finally, we will have to strengthen the technical, material and financial capacities of INRAB and NARS so as tap into the pool of qualified and dynamic teams employed in these organizations. This is one of the necessary conditions for obtaining good results. Strengthening the financial autonomy of the NARS will facilitate the transfer of innovations and their conversion into useful products and information for agriculture, producers, society and the economic and social development of the country.

The following bodies could be good partners in these endeavours:

- MAEP:
  - DICAF;
  - CeRPA.
- Public Research and Extension Institutions:
  - INRAB;
  - Agricultural Research and Training Center.
- Universities:
  - FSA/UAC;
  - FA/UP.
- Farmers organizations:
  - Fédération des Unions de Producteurs du Bénin: an umbrella organization of farmers' organizations. It acts as an interface between agricultural producers, community

development partners on the one hand and farmers and the state on the other hand. The organization participates in the development and implementation of agricultural development programs and the national agricultural policy in its main role of representing and defending the interests of its members.
    - Other national organizations: l'Association des Groupements de Producteurs, la Fédération Nationale des Producteurs Agricoles, la Fédération Nationale des Groupements de Producteurs, etc. These organizations are less acknowledged officially and marginalized by state actors and extension services.
- NGOs:
    - Initiatives for Sustainable Integrated Development.
    - Aquaculture and Sustainable Development
    - Support Group for Management and Research on Environment and Development
    - Institut Africain D'Application Des Méthodes De Développement
    - Others: see Table 10.

National agricultural research, in partnership with the major actors in rural areas, should contribute to the development of the sectors and the diversification of agricultural products, as well as to the constant improvement of productivity levels of the different agricultural crops. But it is still highly dependent on external funding. The challenge is therefore to mobilize more national resources in order to develop adapted technologies that are more performant in terms of productivity, cash revenues, maintenance of environmental balance and conservation in the sectors to be promoted. The recent decision by the Government to allocate more resources to agricultural research should allow all components of NARS to take up this challenge.

INRAB has defined several research lines to better target its intervention relating to the strategic plan to boost the agricultural sector, including the following: availability of quality seeds, technical itineraries and good agricultural practices, improved prost-harvest technologies, processing procedures and the quality of derivative products, sector management and access to markets. Agricultural research in Benin should also take a close interest in agricultural biotechnologies and in bioenergy. It should also integrate aspects relating to the effects of climate changes in order to help in developing adaptation responses. The objective is to put technological innovations, which are adaptive and performing in terms of productivity, cash revenues and environmental conservation, at the disposal of actors promoting target agricultural sectors. Potential German collaboration could therefore take into account the major targets and priorities of the Government of Benin and consider supporting the efforts of NARS, promoting a synergy of actions.

# References

Adegbola Y.P., Arodokoun U., Zoffoun G.A., Ahoyo-Adjovi N.R. and Arodokoun D.Y. (2016). Status of Agricultural Innovations, Innovation Platforms, and Innovations Investment. 2015 PARI project country report: Republic of Benin. Accra and Bonn: Forum for Agricultural Research in Africa (FARA) and Center for Development Research (ZEF), University of Bonn.

Affokpon A. 2014. Enhancement of yam production in Benin through identification and use of local and improved nematode resistant varieties. Laboratory of Biotechnology, Genetic Resources and Animal and Plant Breeding, University of Abomey-Calavi. Abomey Calavi, Benin.

Ahouandjinou M.F. and Arodokoun D.Y. 2008. Rapport d'analyse de l'environnement du secteur de l'agriculture pour la micro finance en zones rurales. Rapport d'étude préliminaire au projet. 165 pages.

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

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

Conseil des investisseurs privés du Bénin. 2007. L'agriculture béninoise: atouts, contraintes et enjeux pour l'investisseur, 56 pages.

DFID. 2004. "Agriculture, Growth and Poverty Reduction" www.dfid.gov.uk/Documents/-publications/agri-poverty-reduction.pdf

Egal, S., Hounsa, A., Gong, Y. Y., Turner, P. C., Wild, C. P., Hall, A. J., Hell, K., Cardwell, K. F. 2005. Dietary exposure to aflatoxin from maize and groundnut in young children from Benin and Togo, West Africa. International Journal of Food Microbiology, 104(2), 215-24.

FAO. 2016. Food security indicators. Retrieved June 17, 2016, from www.fao.org/economic/ess/ess-fs/ess-fadata/en/

FAO and IFAD. 2005. A review of cassava in Africa with country case studies on Nigeria, Ghana, the United Republic of Tanzania, Uganda and Benin. Proceedings of the validation forum on the global cassava development strategy volume 2. Rome, Italy.

FAOSTAT. 2017. Food and agriculture data. Last accessed on January 16, 2017 from: www.fao.org/faostat/en/#home

Gergely N. 2009. The Cotton Sector Of Benin Africa Region Working Paper Series No. 125

Gong, Y. Y., Cardwell, K., Hounsa, A., Egal, S., Turner, P. C., Hall, A. J., Wild, C. P. 2002. Dietary aflatoxin exposure and impaired growth in young children from Benin and Togo: cross sectional study. British Medical Journal, 325(7354), 20-21.

Gong, Y. Y., Egal, S., Hounsa, A., Turner, P. C., Hall, A. J., Cardwell, K. F., Wild, C. P. 2003. Determinants of aflatoxin exposure in young children from Benin and Togo, West Africa: the critical role of weaning. International Journal of Epidemiology, 32(4), 556-562

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

Hell, K., Gnonlonfin, B. G. J., Kodjogbe, G., Lamboni, Y., Abdourhamane, I. K. 2009. Mycoflora and occurrence of aflatoxin in dried vegetables in Benin, Mali and Togo, West Africa. International Journal of Food Microbiology, 135 (2), 99-104

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 et de l'Analyse Economique (INSAE). 2015. Enquête par grappes à indicateurs multiples (MICS), 2014, Résultats clés. INSAE, Cotonou.

Institut National de la Statistique et de l'Analyse Économique (INSAE) and ICF International. 2013. Enquête Démographique et de Santé du Bénin 2011-2012. INSAE and ICF International, Calverton, Maryland.

Lewis, W. A. (1962). Education and economic development. Caribbean Quarterly, 7(4), 171-184.

MAEP. 2012. Elaboration des règles de soutien et de stabilisation des prix pour la filière Palmier à Huile. Office national de soutien des revenus agricoles (ONS). 103 pages.

MAEP. 2015. Rapport de Performance du Secteur Agricole, Gestion 2014. Rapport d'Activité. 92 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 www.ncbi.nlm.nih.gov/books/NBK279095/

New Alliance. N.d. G8 Cooperation Framework to support The New Alliance for Food Security and Nutrition in Benin. Accessed from: new-alliance.org/sites/default/files/resources/Cooperation-framework-Benin1.pdf

PAHO/WHO. 2003. Guiding principles for complementary feeding of the breastfed child. PAHO, Washington DC.

Rapsomanikis, G. 2014. The economic lives of smallholder farmers; An analysis based on household surveys. Rome: Food and Agriculture Organization.

Scaling Up Nutrition. 2017. Homepage. Accessed from: scalingupnutrition.org/

Sewade P. 2016. Etat des lieux du sous-secteur semences soja au Bénin: Pourquoi le ProSeSS? Communication pour l'Atelier de Lancement de ProSeSS, Cotonou, le 03 février 2016.

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

Totin E., van Mierlo B., Saïdou A., Mongbo R., Agbossou E., Stroosnijder L., Leeuwis C. 2012. Barriers and opportunities for innovation in rice production in the inland valleys of Benin. NJAS – Wageningen Journal of Life Sciences, 60(63), pp. 57 – 66.

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. Global Hunger Index 2014: 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

Zoffoun A. 2014a. Répertoire des chercheurs en sciences agricoles, Rapport d'Etude PPAAO, Benin

# Annex A: Background Information on Nutrition

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

## Background on food and nutrition security

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

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

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

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

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

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

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

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

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

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

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

## Indicator definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

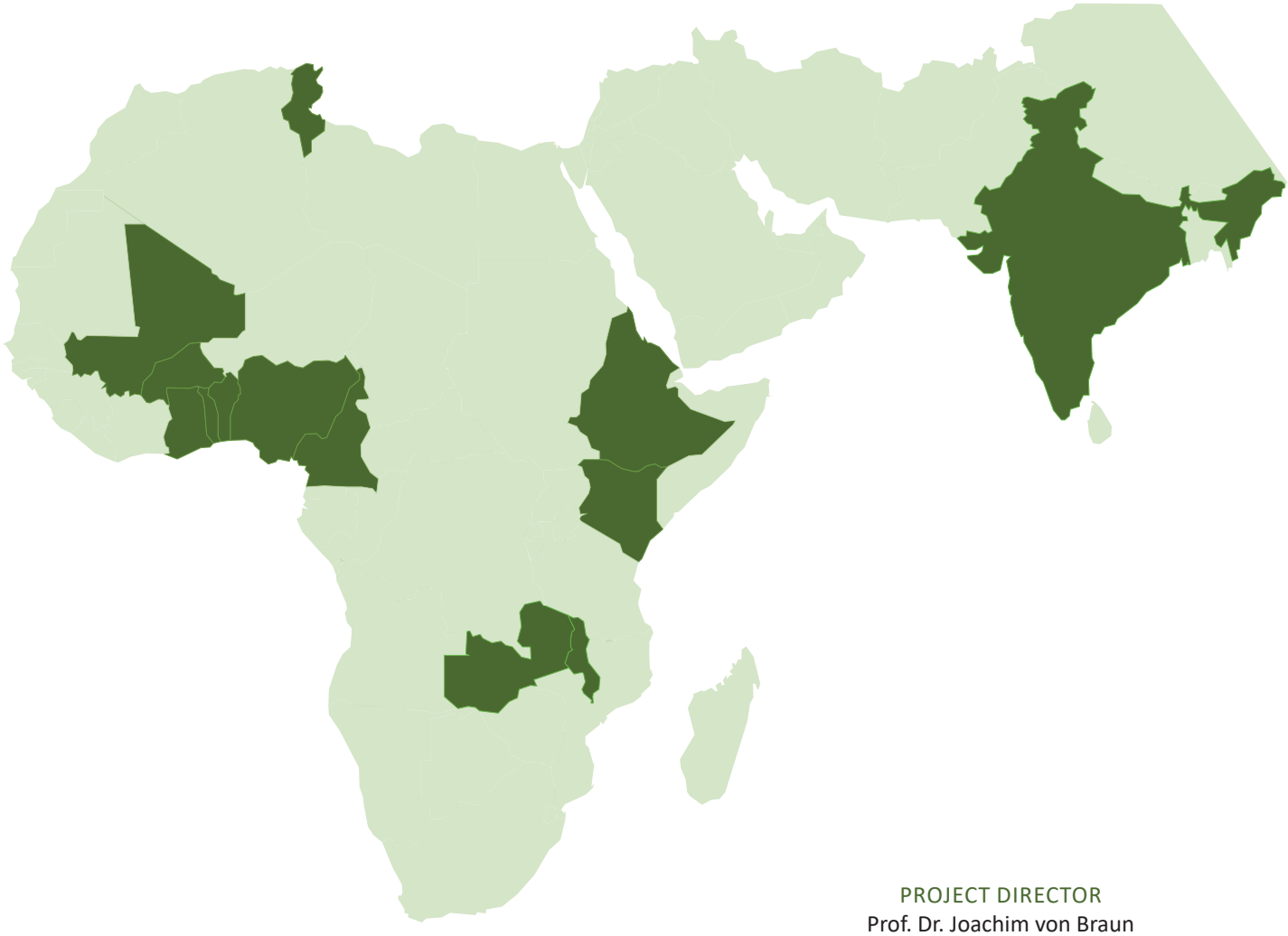
**Vitamin A deficiency:** Percentage of children aged 6-59 months with a serum retinol concentration below 0.7 µmol/l.

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

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

## ABOUT PARI

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

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