Recipes for Change validation report: Senegalese Poulet Yassa

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In collaboration with

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Recipes for Change: Senegalese Poulet Yassa

Summary statement for selected ingredient onion

The main climate risks to onion cultivation in Senegal are: (i) the availability of water resources in the major growing regions (particularly the Niayes region); (ii) increased incidence of extreme rainfall events and resulting damages to infrastructure; and (iii) the negative effects of sea level rise including inundation, erosion and salt water intrusion (again, specifically in the Niayes region).

The key adaptation measures for managing the foreseen impacts of climate change upon horticulture within the region include: (i) coastal and estuary infrastructure projects to protect against hazards exacerbated by sea level rise, e.g. dikes, sea walls etc.; (ii) improved management of water resources and irrigation technologies; and (iii) interventions to support horticultural market development and smallholder market linkages.

CCAFS validates the climate threats and solutions highlighted in the IFAD statements below.

IFAD-identified climate threats to onions:

- *Rising sea levels.*
- *Increased levels of salt in agricultural land.*
- *Erratic rainfall and weather patterns.*

ASAP solutions:

- *IFAD helps communities adapt to climate change with techniques such as soil washing and dike building.*
- It also helps farmers gain easier access to markets and obtain a fairer distribution of profit.

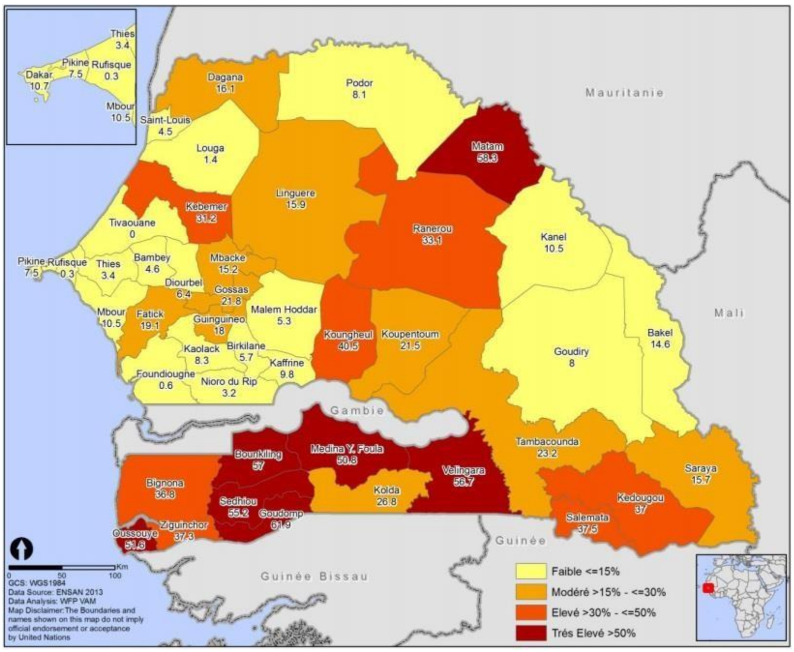
National context and food security overview

In a ranking of African nations by development status, Senegal sits roughly in the middle. However, seen globally, Senegal is very much at the lower end of the scale, sitting at 163 out of 187 countries according to the most recent measure of the Human Development Index (HDI) (UNDP 2014). This HDI ranking has improved over the years and the level of poverty in Senegal has been decreasing gradually. However, poverty still remains a widespread problem, particularly in very poor rural sections. The latest survey from the Senegalese government highlights a pronounced urban-rural divide with estimates showing 58% of rural households as being below the poverty threshold compared to 34% in the Dakar capital region (ESAMII 2011). The difference in economic opportunities between rural and urban areas is a major driver of the significant urbanization trend in the country. Another significant demographic trend is population growth itself. Senegal has one of the highest population growth rates in the world, with current projections foreseeing a doubling of the current 13 million in the next 2-3 decades (UNDESA 2011).

Senegal is far from meeting basic food requirements through domestic production alone and is highly dependent on imports for major food crops. Around half of the cereals consumed are imported, mainly rice (~55% of imported cereals) and wheat (~35% of imported cereals) (FAO 2014). This dependency leaves the country vulnerable to changes in the price of internationally traded food commodities, with negative outcomes for food security and social stability. For example, the food price surges of 2008 and 2011 resulted in a near doubling of prices at markets in Dakar, leading to protests and riots. As an average across the entire country, 16 percent of the population are classified as food

insecure (not meeting their minimum food needs without resorting to unsustainable coping strategies) (WFP 2014). However, as shown in Figure 1 below, in some regions the food security situation is far worse. These worst-off regions, already facing stresses of persistent conflict across the wider Casamance region, were strongly affected by the food crisis of 2012 (ibid.). The government has responded to recent crises with an ambitious national food sovereignty programme, the Grand Agricultural Offensive for Food and Abundance (GOANA), which set the goal of national self-sufficiency by 2015 through a 250% increase in rice production as well as a tenfold increase in the production of cassava (IFPRI 2011). However, the programme's goals have yet to materialize (Diagne et al. 2013).

Figure 1: Prevalence of food security by region (numbers represent % of region's population classified as food insecure) (WFP 2014)



Much of the agricultural area is subject to irregular rainfall and only around 5.5 percent is currently under irrigation (Cinyabuguma & English 2014). As such, cultivation is mainly rainfed and seasonal, which explains the significant year-to-year variation in production levels. The sector constitutes approximately 16% of economic output in Senegal and is a major employer, with around 75 percent of the working population engaged (OECD 2014). Cash crops dominate the agricultural sector, with groundnut production accounting for 40 percent of cultivated land and cotton production another 33 percent (Bolwig et al. 2011). However, the sector's contribution to economic growth and stability has lessened in recent years, largely attributed to climatic shocks (mainly drought and flooding) as well as poor management of intensive monocropping, irrigation and seed distribution (ibid.). Furthermore, the Senegalese groundnut sector has struggled to maintain its historic position of market dominance in an increasingly competitive global market (Poulton & Tyler 2007). Key subsistence crops include millet and sorghum and extensive livestock herding is found in the north of the country. However, most households do not produce enough food to meet their minimum food requirements and purchase is by far the principal means of obtaining food for most households (87 percent for rural areas and 97 percent for urban areas) (WFP 2011).

Accordingly, improving food security in Senegal is to a large extent a task of securing incomes by achieving stable production of readily marketable products. This has been the route charted by the booming horticulture sector, which has seen diversification into higher value products (e.g. onion, tomato, cabbage), catering to a relatively wealthier urban domestic market and an off-season export market. Horticultural production volumes have increased nearly

sevenfold over the last decade, with significant expansion in cultivated area in the Niayes region (the coastal zone between Dakar and Saint Louis) and the irrigated lands along the Senegal River (OECD 2014; Ndiaye 2007). Onion growing has performed particularly strongly, with record production levels in 2014 of 350,000 tonnes, almost four times the yield, compared to a decade ago (Freshplaza 2015). Continued development of the horticulture sector will require several constraints to be successfully managed, including poor access to agricultural inputs (seeds, fertilizers, pesticides, land, and agricultural machinery), limited domestic capabilities in commercialization and marketing and lacking storage, packaging, processing and transport infrastructure (Giunta et al. 2014). In addition to these factors, cultivation also risks negative impacts consequent of the exposure to several climatic hazards, most of which pose an increasing threat under ongoing climate change. The following sections describe these hazards in more detail, as well as measures suited to managing and adapting to these foreseen impacts.

Climate risks to horticulture

The climate of Senegal is characterized by low mean annual rainfall, a short rainy season and the great spatial and temporal variability of rainfall (Bolwig et al. 2011). These characteristics are comparable to most countries in the West Sahel where there exists a steep rainfall gradient, ranging from as little as 100-200mm per year in the north to 800-1000mm per year in the south (WFP 2013; Bolwig et al. 2011). The key meteorological feature and main source of rainfall to the region is the West African Monsoon (WAM). The rainfall this brings is generally limited to the northern hemisphere summer months, with a season length ranging from 1-2 months in the north-Sahel to 4-5 months in the south-Sahel, and with maximum rainfall occurring in August (Nicholson 2013). Winter rains are rare and insignificant compared with the monsoon (ibid.). Historically the monsoon has shown significant fluctuations on interannual and interdecadal timescales. The most remarkable drought period started in the late sixties/early seventies and persisted into the mid-eighties, causing significant environmental change and devastation to the population (Bolwig et al. 2011). More recent occurrences of drought have been more short-lived but still impact heavily upon the agricultural sector (ibid.) Making an assessment of future climatic conditions in the region is challenging, as the WAM system itself is poorly represented by global climate models. Regional climate models have shown greater ability to reproduce historic patterns, but confidence over future projections, particularly of precipitation trends, remains low. Following sections provide further description of the main observed and projected trends in climate parameters across the wider West African region. Table 1 below provides a summary of these trends.

Table 1: Summary of observed and projected changes in climatic across West African region (Niang et al., 2013)

	Temperature trends	**Trends extreme temperatures**	**Precipitation Trends**	**Trends in extreme precipitation**
Observed changes	+0.5-0.8°C between 1970 and 2010, acceleration in last 20 years.	Number of cold days and cold nights has decreased and the number of warm days and warm nights has increased.	Very likely decreases in annual precipitation over the past century over parts of the western Sahel. Significant and prolonged droughts during the 1970s and 1980s.	Significant rainfall variability a consistent feature.
Projected changes at end of 21st century	+1.5 (RCP2.6) - +6 C (RCP8.5)	Increase in temperature extremes under all warming scenarios.	± Annual levels highly uncertain – low confidence in all projections. Early onset/late end of the monsoon projected with low/medium confidence.	Increased interannual variance. Low/med confidence of increase in extreme rainfall events (5-day max). Increase in dry day periods (CDD). Surface runoff: projected increase is marginal.

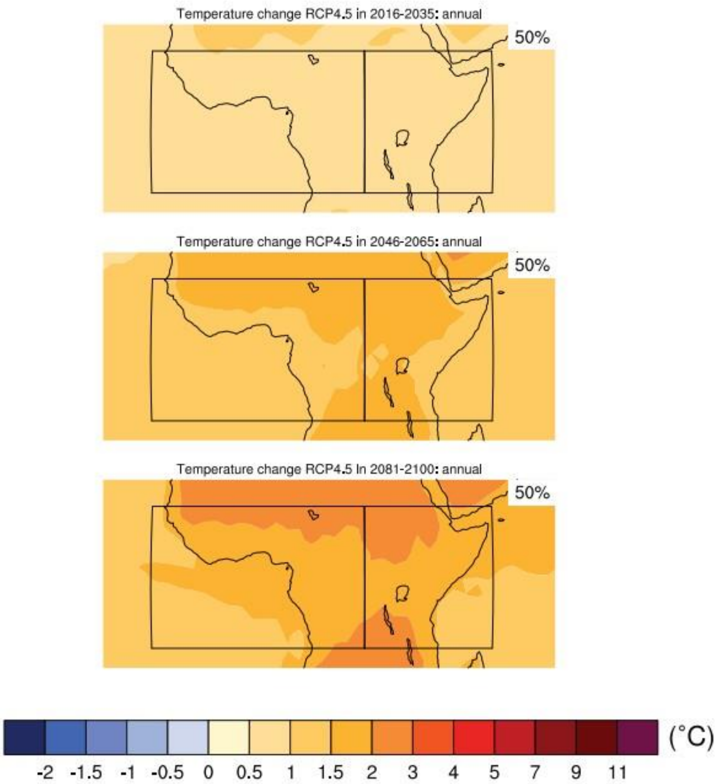
Observed temperature changes

The latest assessment from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) states that the mean annual temperature has very likely increased over the past century over most of the African continent (Niang et al. 2013). In the West African and Sahel regions, observations indicate a warming of between 0.5°C and 0.8°C between 1970 and 2010, with a greater magnitude of change in the last 20 years of the period compared to the first two decades (ibid.).

Projected temperature changes

Recent assessments indicate that increases in mean annual temperature over all African land areas are very likely in the mid- and late 21st-century periods under both low and high emissions scenarios (RCP2.6 and RCP8.5) (Niang et al. 2013). Specific to the Western African region, temperature projections are similar to those foreseen at the wider scale (~2°C for RCP2.6 and ~6°C for RCP8.5). Nevertheless, temperature increases are expected to be marginally less for Senegal than for the centre of the African continent, possibly due to a proximity to the Atlantic.

Figure 2: Projected temperature changes by through the 21st century under medium warming scenario (RCP4.5) (Niang et al. 2013)



Observed precipitation changes

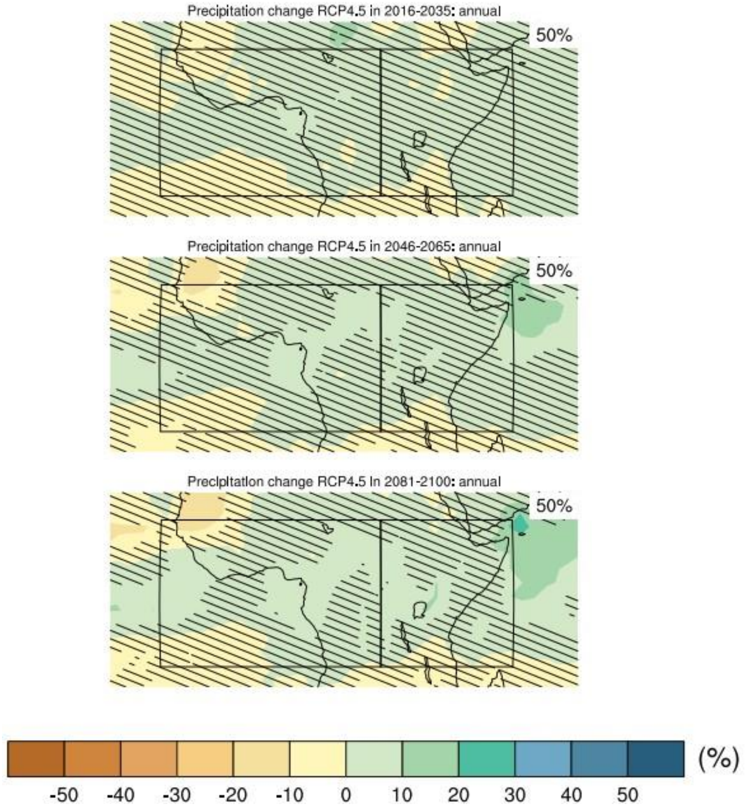
Much of the African continent as lacking sufficient observational data from which to make a firm assessment as to the trend in annual precipitation over the past century (Niang et al. 2013). However, parts of the Sahel are among the few regions with long-term datasets. These data indicate very likely decreases in annual precipitation over the past century (ibid.). However, longer-term trends mask significant variability, most notably a prolonged negative precipitation anomaly and large number of droughts during the 1970s and 1980s. Subsequently, rainfall over the Sahel during the last two decades has experienced a recovery (WFP 2013). However, whether this recovery is a

consequence of natural variability, a forced response to increased greenhouse gases or reduced aerosols, remains unknown (ibid.).

Projected precipitation changes

The latest assessment from the IPCC's Fifth Assessment Report underscores how precipitation projections are more uncertain than temperature projections and show greater variation depending on location and season than for temperature projections (Niang et al. 2013). The signal for precipitation changes under climate change is strong in some regions of Africa (such as the north and south). However, in the west of the continent, regional climatic and meteorological phenomena (namely convective rainfall, a key process of the African monsoon[1]) are poorly represented by global climate models (GCMs), evaluated in the IPCC's latest assessment. Consequently, models disagree on the magnitude and direction of change in precipitation levels in future years and overall there is low confidence in projection statements about drying or wetting of the West African region. With regard to the African Monsoon, projections indicate a slight change in the onset date and a small delay in the retreat date, leading to a small increase in the duration of the rainy season (Christensen et al. 2013). This delay in the monsoon retreat is larger in the high-end emission scenarios. Furthermore, the interannual variance and the 5-day rain intensity show a robust increase, while a small increase in dry day periods is less significant (ibid.). Overall there is medium confidence in projections of a small delay in the rainy season with an increase at the end of the season (ibid.).

Figure 3: Projected change in annual precipitation through the 21st century under medium warming scenario (RCP 4.5). (Hatching denotes where trends do not depart significantly from natural variability) (Niang et al. 2013).



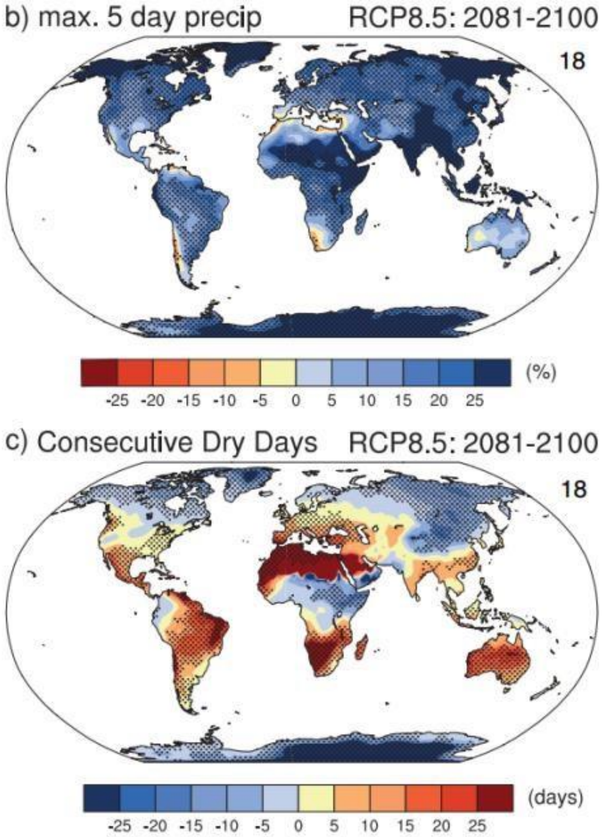
[1] Rainfall maxima occur during the peak of the West African monsoon (WAM) in June–July–August (JJA) and are associated with the meridional displacement of the intertropical convergence zone (ITCZ).

Observed and projected changes in extreme temperature and rainfall

The average warming observed and projected across West Africa and the Sahel will also have implications for extreme temperatures. Recent assessments detail how the number of cold days and cold nights has decreased and the number of warm days and warm nights has increased in this region (Niang et al. 2013). Similar trends in extreme temperature indices (i.e. heatwaves) are also observed. Across the region as a whole, there is high confidence that heat waves and warm spell durations and prevalence will increase toward the end of the century (ibid.).

Flooding events have been documented as becoming more frequent in recent years (WFP 2013). Expansion of impermeable urban areas and increased rainfall variability are both expected to play a role in the observed trend (ibid.). Heavy rainfall is also expected to increase in future years, with the number of days experiencing extreme rainfall events increasing over West Africa and the Sahel during the onset of the monsoon period, although projections are assigned low to medium confidence (Niang et al. 2013; Roudier et al. 2011). Figure 4 below, also taken from the IPCC's Fifth Assessment Report, depicts this change in extreme rainfall events at the global scale, showing the relative change in maximum five-day precipitation events. Also shown in the figure are projected low precipitation extremes, signified by the change in annual consecutive dry days (CCD). The figure indicates West Africa as being one of the regions experiencing the greatest increase in CCD globally.

Figure 4: Projections of changes in extreme hydrological indices by end of 21st century (stippling in the figure indicates regions of high agreement between projections produced by different models) (Collins et al. 2013)



Impacts of projected climate change on agricultural systems

Climatic conditions are undoubtedly a key explanatory factor for the types of agricultural practices employed in Senegal. For example, low intensity pastoralism dominates in the arid North, whereas agro-forestry and the cultivation of cash crops prevail in the wetter south (WFP 2014). Vegetable production is concentrated in those regions where water resources are available (i.e. the Senegal River Valley, along the northern border of the country) or where the hot, arid climate is moderated by a cooler, wetter maritime microclimate (i.e. the Niayes coastal region) (Giunta et al. 2014). Consequently, changes in climatic conditions may affect the productivity of established cultivation practices. This has been evidenced most strongly by the observed covariance of precipitation and yields of the major crop types in Sengeal (rice, millet, groundnuts, and sorghum) (WFP 2014). Use of irrigation in horticulture can partly mitigate the effects of rainfall variability on yields. However, not all horticulture farms make use of irrigation practices, at least not year-round (Giunta et al. 2014). Specific to onion cultivation, the majority of national production is split approximately equally between the Niayes coastal region and the Senegal River Valley (MAER 2014, APS 2013). Water availability in the valley is primarily a function of river discharge, which in turn is determined by rainfall in the Fouta Djalon Mountains in Guinea and southern Mali, and on the management of the Manantali dam in Mali. Modelling studies provide some evidence that climate change may affect rainfall within the Upper Senegal Basin, with impacts upon the recharge of subsurface water resources as well as river discharge (Mbaye et al. 2015). However, it is less well established whether this change would be sufficient to reduce the availability of water resources for irrigation in the valley region (ibid.). Finally, an increasing prevalence or intensity of extreme rainfall events could increase flooding risk, with negative effects on farm and transport infrastructure (WFP 2014). This outcome would further reduce the ability of households to access markets to sell and purchase food (ibid.).

Sea level rise

Several coastal nations in West Africa are exposed to intrusion of salt water, erosion and inundation due to storm surges. The combined effect of see level rise and storm swells will further contribute to this hazard (Niang et al. 2013). Along the 500km of Senegalese coastline, major urban centres (such as the Cap-Vert peninsula) and the deltas (Saloum and Casamance estuaries) are particularly vulnerable, even under modest SLR scenarios of 0.5-1m (Naing et al. 2010). Of specific interest to the horticulture sector is the low-lying Niayes region, the strip of fertile land running between Dakar and Saint-Louis which provides nearly 60 percent of the capital region's vegetables (Dasylva 2012). The coastal lakes and agricultural areas of the low-lying Niayes are particularly at risk for saltwater intrusion and to a lesser extent inundation (Sy et al. 2014).

Adaptation to climate hazards

Farmers in Senegal have always pursued livelihoods under conditions of significant climatic variability and ongoing environmental and socioeconomic change. Numerous strategies have been employed in order to cope and adapt to change, many of which have become embedded in local agrarian systems and cultures (such as crop and livelihood diversification as well as migration) (Bolwig et al. 2011). As highlighted above, the conditions of climatic variability are likely to persist and, in some aspects, intensify under ongoing climate change. Therefore, the development of measures which are designed to systematically alleviate the risks presented by climatic hazards are warranted. However, specific adaptation measures guided explicitly by anticipated future climate realities as opposed to measures which support adaptive capacity more generally are less well suited to the Senegalese context, where some aspects of future climatic charge are uncertain (Mertz et al. 2009). Furthermore, certain socioeconomic changes are likely to have at least as much of a bearing on farmers' livelihoods (such as the application/removal of import tariffs or production subsides) as progressive changes in the climate. Therefore, as a general statement covering all adaptation options in this context, measures that have a high chance of yielding benefits regardless of future climatic or socioeconomic changes (so called 'low/no regret' options) should take priority (Verbruggen et al. 2007).

Inadequate access to quality irrigation water in key growing regions, particularly in the Niayes, represents one of the main constraints on the development of the horticulture sector (Veenhuizen 2006). The water resource in the area is characterized by a shallow water table, which has lowered progressively after several successive rainfall deficit years and a significant increase in demand for domestic and industrial use in urban centres (MPEN 2006). Saline intrusion and nitrate pollution are further degrading the quality of the resource (ibid.). In a recent assessment from UNEP of urban and peri-urban agriculture in less-developed countries, several options relating to water and irrigation management were highlighted as priority actions for the Eastern Dakar city region including: improved handling of wastewater irrigation; biological and/or mechanical treatment of wastewater; training and financing programmes that promote uptake of drip/micro irrigation practices; and targeted research for the production horticultural varieties better suited to warm and saline conditions (Sy et al. 2014). Additional issues concerning water resources relate to managing competing interest in urban and semi-urban contexts, such as better land management that caters to both local producers and investors, or greater collaboration between water suppliers and producers in order to establish fair tariffs for agricultural purposes (idid.). Furthermore, hard infrastructure projects which defend against sea-level rise, storm surges and associated hazards such as salt water intrusion have been highlighted as indispensable for urban and semi urban sites (Silver et al 2013).

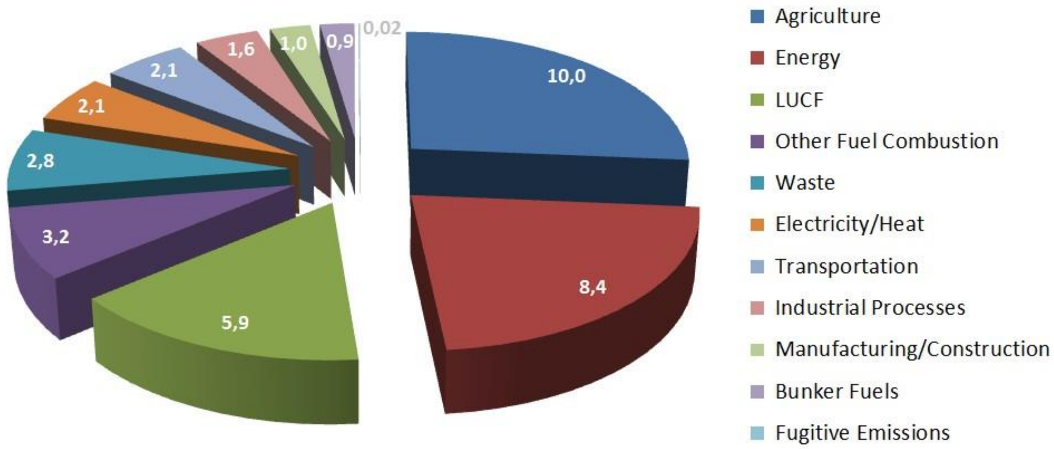
As is the case for many smallholder farmers across various regions, marketing produce at stable prices is also a major problem for horticulturalists and market gardeners in Senegal. Poor storage and transport infrastructure often limits sale to the locality, and the resulting pinches on local supply through the season can lead to dramatic price fluctuations. Furthermore, many farmers make use of middlemen to market produce, where the trade is based on a fixed price per volume (PAN 2007). Consequently, farmers themselves are less able to respond to market dynamics in a way that secures the best price for their produce. The resulting reduction on incomes and a lack of predictability is an impediment to investment in farm inputs, machinery and infrastructure, thus consigning smallholders to a cycle of low output, volatile prices and low income. Remedying this problem will require intervention from numerous actors at different scales (see Wiggins 2013). However, two aspects are critically important for supporting a strong horticultural sector in Senegal. First, the delivery of basic public goods to create an enabling environment for the development of functioning markets is essential, including transport infrastructure, stability and security, the upholding of business principles such as property rights and trading standards. Second, improvements to the main organizational links between farmer and market, specifically, through the grouping of growers into associations or cooperatives, or by making use of dealers or appointed distributors, lead farmers or bank agents. Furthermore, promoting contracting arrangements that reach directly to the producers themselves has shown to provide the greatest boost to incomes, albeit with trade-offs in terms of smaller operations' bargaining power and their ability to meet quality standards for the highest value export products (Swinnen 2007, Dedehouanou et al. 2013).

GHG emissions associated with horticulture:

Figure 5 below shows data compiled by the World Resources Institute on greenhouse gas emission by sector for Senegal. These data show the predominance of the agricultural sector as an emissions source. The livestock sector, through processes of enteric fermentation and decomposition of manures, accounts for approximately half of these agricultural emissions (FOA 2015). The burning of savanna is also a considerable emissions source – some 3,777 $MtCO_2e$ in 2011. The degradation of soils, which has resulted from long-term drought and land use change, has affected terrestrial carbon stocks across the African Sahel. At 3,300 $MtCO_2e$ in 2011, this disturbance is also a significant source of emissions within Senegal (ibid.). Net emissions/removals attributed to land use and land use change (LULUC) (inc. biomass burning) were also approximately 7,000 $MtCO_2e$ in 2011, primarily a result of deforestation and to a lesser extent the burning of biomass (ibid.).

Mitigation strategies within the Senegalese land and agricultural sector have predominantly targeted forest, soil and pastoral systems. Forest clearing in Senegal is mostly a result of clearing for fuelwood, charcoal, and logging (UNEP 2013). Mitigation projects making use of the Clean Development Mechanism (CDM) and Reducing emissions from deforestation and forest degradation (REDD) projects have gained limited traction in the country, despite having shown considerable mitigation potential (ibid.). Such projects may also carry co-benefits in terms of alleviating detrimental effects of forest clearing on agriculture, namely increased soil erosion. Improved management practices have been evidenced as being capable of stemming emissions that resulting from pastoralism activities in dryland regions (Gerber et al. 2013). These include efforts to improve forage quality to increase digestibility and animal/herd performance and improved livestock husbandry and breeding practices to reduce mortality and increasing fertility, thus improving animal and herd performance (ibid.). Detailed accounts of mitigation strategies specific to horticulture sector, particularly in an African context, are not found in the literature. However, two aspects relating to mitigation have been noted in studies of urban and peri-urban agriculture in Sri Lanka and Argentina. Firstly, the recycling of domestic wastewater for irrigation purposes can reduce energy needs for pumping (Dubbeling 2015). Furthermore, it should be noted that growing fresh produce close to urban centres (as is increasingly practised in the Dakar and Saint-Louis regions) may use less energy for transport, cooling, storage, processing and packaging when compared to sourcing equivalent products through imports alone (ibid.).

Figure 5: GHG emissions in Senegal by source (data for 2011 in $MtCO_2e$. Total emissions in 2011 – 36.3 $MtCO_2e$) (WRI 2014)



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