



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Adaptation & mitigation in the Senegalese cereal milling industry

Country report



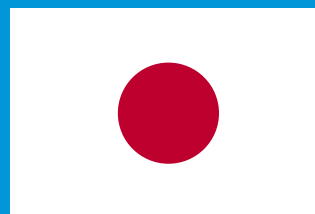
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Publication work of this report was coordinated by Smail Alhilali (UNIDO) and Nahomi Nishio (UNIDO), and designed by Maria Grineva and Mauricio Mondragon (Athenea Omnilang).



From the People of Japan

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- **Capital:**
Dakar
- **Surface:**
196,722 km²
- **Population:**
13.9 million
- **Demographic growth:**
2.7%
- **Annual rainfall:**
687mm



BACKGROUND OF THE CEREAL MILLING INDUSTRY IN SENEGAL

The cereal milling industry in Senegal mainly serves the domestic market (Matsumoto-Izadifar, 2008), providing important staples and critically contributing to the country's food security. Even so, cereal-based exports are estimated at 9% of food-related exports, approximately 105 million USD (Center for International Development at Harvard University, 2016; World Bank, 2016).

Dakar has 95% of Senegal's industry (Programme des Nations Unies pour le Développement, 2009), including the major cereal mills. There are six major milling companies in Senegal, although Grand Moulins de Dakar (GMD), Nouvelle Minoterie Africaine (NMA) (who took over the major miller, les Moulins Sentenac, in 2015), and Olam supply the majority of market (Bathily, 2015; Styles, 2013).

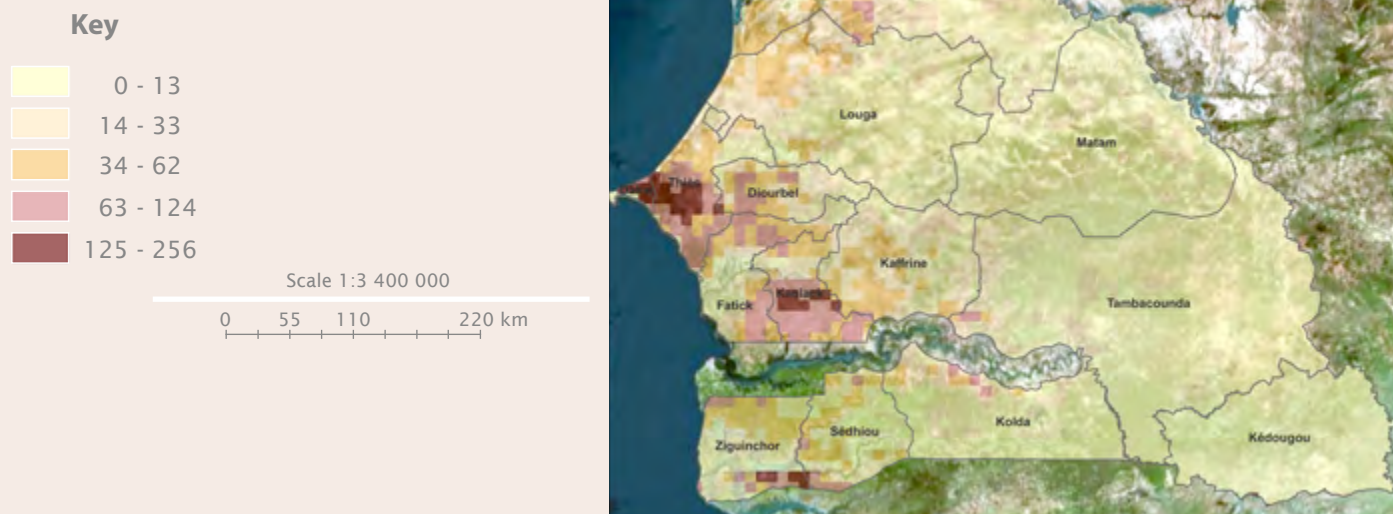
Cereal production is a significant part of the rural economy, especially for smallholder farmer subsistence (Food and Agriculture Organization of the United Nations (FAO), 2015; Jalloh, 2013). In 2014, rice was 45% of grain produced in Senegal, millet 33%, maize 14%, and sorghum 8% (FAO, 2015). Although maize and millet are grown widely (Yaciuk & Yaciuk, 1980), most rainfed agricultural production comes from the Southern 'groundnut basin' region where maximum temperatures are lower and rainfall is higher than the northern Sahel region (Jalloh, 2013; Our Africa, 2016). Rice is grown with recessional flooding and irrigation along the Senegal River on the north border, whilst paddy rice is grown in Casamance in the south (see Figures 1&2). Due to its popularity, wheat is also commonly milled, but the grain is mostly imported (Bassi, 2014).

Despite improvements over the past decade (Jalloh, 2013) and the leadership of the Senegal food-processing industry in West Africa (The Western Cape Destination Marketing and Trade Promotion Agency South Africa (WESGRO), 2013), the cereal milling industry is acutely exposed to the impacts of climate change throughout the value chain where a lack of access to inputs, extension, equipment, technical guidance and development has led to underperformance and created vulnerabilities. Climate change in Senegal is predicted to manifest as a decrease in the amount of rainfall—however with increased intensity, increased temperatures, and sea-level rise. Drought and saline intrusion threaten water supplies, while sea-level rise along with coastal erosion threaten infrastructure (UNDP, 2016).





Figure 1. Agricultural concentration in Senegal (and Gambia).

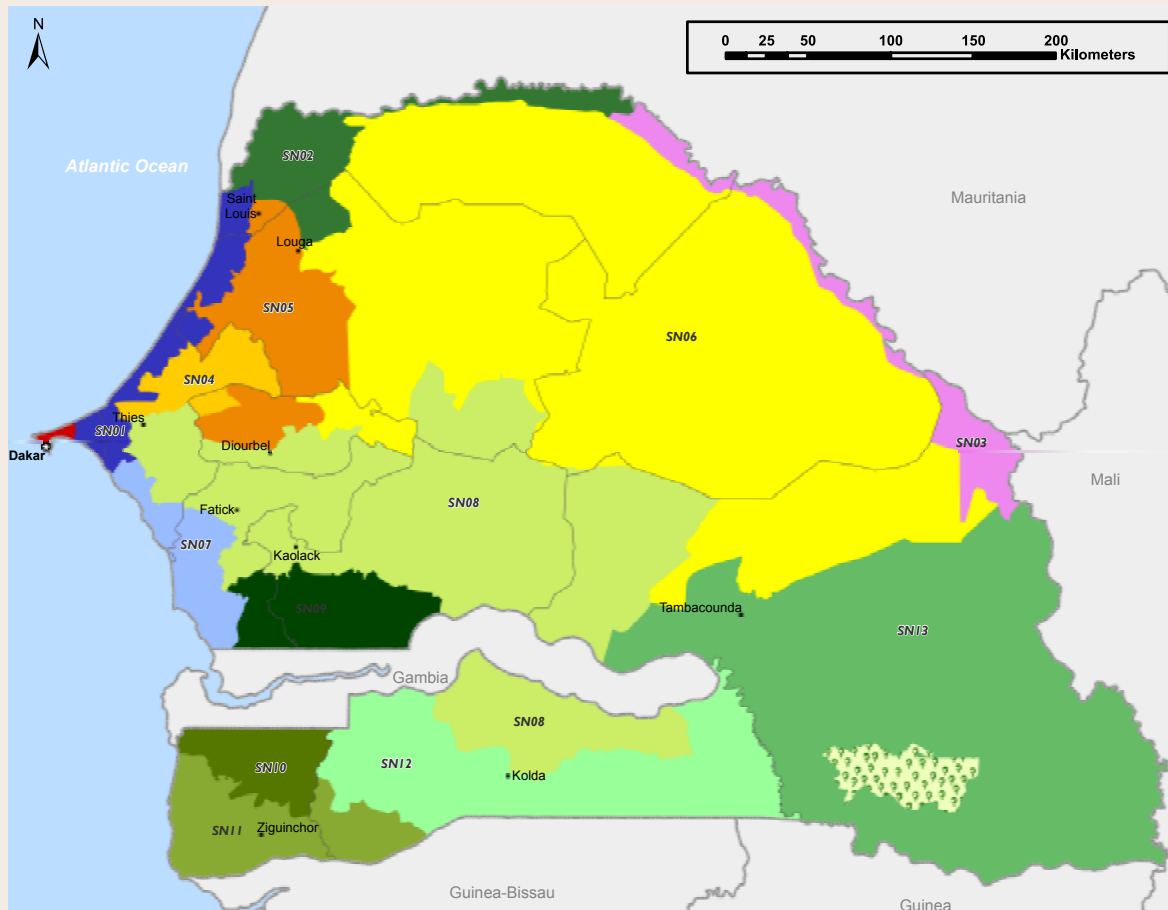


Source: Ramankutty, Evan, Monfreda, & Foley, 2008.

Comment: Key indicates the concentration of agriculture (% of each ~100 km² cell that is cultivated)



Figure 2. a) Livelihood zone map of Senegal.



Key

SN01 Niayes Horticulture and Fishing Zone	SN06 Sylvo-pastoral	SN11 Agroforestry, Fishing and Tourism Zone
SN02 Senegal River Valley: Rice and Gardening Zone	SN07 Petite-Côte: Fishing, Tourism and Arboriculture Zone	SN12 Agro-sylvo-pastoral: Peanuts and Cotton Zone
SN03 Senegal River Valley: Out-migration and Remittance Zone	SN08 Agropastoral: Peanut Zone	SN13 Agro-sylvo-pastoral: Food Crops Zone
SN04 Agropastoral: Cassava Zone	SN09 Agriculture Zone	SN14 Not Zoned: Urban Area
SN05 Agropastoral: Cowpea Zone	SN10 Food Crops and Forestry Zone	

Source: FEWS NET, 2014.



Figure 2. b) Agricultural zones of Senegal



Source: Le Fur, 1988.

Comment: Blue areas north and south are irrigated rice. Other cereal growing regions are dark and light orange; dark orange representing higher concentration

IRD - Cartographie A. LE FUR-AFDEC



A GENERIC VALUE CHAIN OF CEREAL MILLING (FOR FLOUR) IN SENEGAL

Flour milling primarily used wheat which in turn is used mostly for producing bread. Wheat accounts for about 80% of the cost of flour. Wheat is much more actively traded than flour, with the latter accounting for less than 10 percent of trade, due to both ease of shipping for wheat and greater import protection of flour (FAO 2009). There are four flour producers, with the largest being the Grands Moulins de Dakar, controlled by the same family that owns the sugar monopoly CSS, with about 65 percent market share of the flour market. Millers manage their own imports of wheat, from which they produce flour as well as animal feed, with higher profit margins on the latter. Flour is sold to bakeries on credit (Mbay, et.al. 2015).

The Swedish University of Agricultural Sciences (SLU) and The International Center for Agricultural Research in the Dry Areas (ICARDA) found through research that wheat is better adapted to the region of the Senegal River and better suited to resist the changing climates. Through an innovative approach developed by SLU and ICARDA, wheat varieties are tested simultaneously in various sites along a North-South gradient in Senegal (CGIAR, 2014).

Cropping & Harvesting

Plantation process requires significant water from irrigation and rainfall. Therefore, timing is critical for optimal grain harvest. Many cereal crops are often laboriously harvested by hand; however, combine harvesters may be used where afforded. Grain is air-dried and threshing can be done by hand, but small machinery such as the Bamba thresher or Votex thresher are increasingly used where available. Larger grain

Figure 3. Cereal milling (for flour) production chain





operations employ larger machinery and artificial drying at this stage. Harvesting and collecting are used to be done by the farmers themselves.

Transportation & Storage

Due to climate and temperature fluctuation, storage requires significant energy demand. Climate zone cereal production areas in Senegal are semi-arid and tropical savanna. These are the suitable micro-climate conditions for cereal, particularly in the plantation stage. There are a range of storage structures, varying by means and climatic zone. Stored grain must be protected from molds, bacteria, and rodent, bird and insect damage, for which insecticide treatments are used. At a factory, grain is graded and sometimes sieved of foreign matter before silage.

Cleaning, Dehulling, Milling, Granulation, Grinding

The milling process can be conducted with small-scale mill technologies, all the way up to large hi-tech milling installations, but the process remains loosely as follows: Before being ground into flour, the grain is thoroughly cleaned through numerous processes, passing through screens and an aspirator repeatedly. Other separators, sieves and even scourers may also be used. The mechanically cleaned grain is washed and dried, after which, the grain might be tempered to assist in dehulling or removing the bran and germ. Milling begins when the grain is repeatedly passed through rollers that break off the bran and germ and granulate the endosperm,

which are sieved into separate pure components. Only after the bran and germ have been completely removed can the remaining material (middlings) be ground into flour, again a process of sifting and reprocessing until the desired characteristics are reached.

Cooking & Drying

Cooking and drying processes are required if value-added products like biscuits, pasta or noodles are to be made from the processed flour.

Packing

Small amounts of bleaching agents and oxidizing agents are usually added to the flour after milling. Other additives may include vitamins and minerals for enrichment, and leavening agents. Depending on the operation size, the flour is packaged into cloth bags or bulk receptacles, shaken to settle its contents, and matured.

Distribution

Dispatch of packaged flour from large factories is contracted to lorries. The distribution is done by road transportation with various distance and duration. There is cultivated area in the Dakar region grew from 5,098 hectares (IPS, 2016), this area has easier distribution task rather than area outside of Dakar region. Condition of road and traffic in Senegal needs serious maintenance. Senegal is one of the African countries which is undertaking studies for the creation of second generation road funds by UN (Benmaamar, 2006).



STAKEHOLDERS' PERCEPTIONS OF THE IMPACTS OF CLIMATE HAZARDS ON EXPOSED INDUSTRY PROCESSES

In 2015, as part of the vulnerability assessment, a vulnerability matrix (Table 1) was compiled to capture the extent to which stakeholders perceive various climate hazards as impacting industry production processes. Representatives from stakeholders were involved. These stakeholders' perceptions of current and past climate vulnerability can offer insights and inform priorities for climate change adaptation (Stockholm Environment Institute, 2007).

The vulnerability matrix (Table 1) shows the climate hazards identified by stakeholders as threats to the cereal milling industry (top row), each evaluated on a scale of 0-3. The rating depended on the perceived degree of impact the climate hazard would have on components of the production process (first column).

Being subject to climate hazards, the production process components are referred to as exposure units (see methodology report for detail).

The scale was delineated as: 0 = no impact on exposure unit, 1 = low impact on exposure unit, 2 = medium impact on exposure unit, 3 = significant impact¹ on exposure unit. The 'Number of 3s' reveals stakeholders' perception of the impact.

Stakeholders perceived a threat of significant impacts from climate hazards on the following exposure units: harvesting (4), storage (3), cooking (2), and

Table 1. Vulnerability matrix

	Flood	Drought	Insect invasion	Heavy rain	Delayed rain season	Early rain season	Warming	Strong winds	Number of 3s
Frequency	+	+	+		+		+	+	
Harvesting	3	3	3	2	1	1	0	3	4
Transportation	2	0	0	1	0	0	0	0	0
Storage	3	0	3	3	0	0	0	0	3
Cleaning	2	0	0	0	0	0	0	0	0
Dehulling	2	0	0	0	0	0	0	0	0
Mill	2	0	0	0	0	0	0	0	0
Granulation	2	0	0	0	0	0	0	0	0
Grading	2	0	0	0	0	0	2	0	0
Cooking	2	0	0	0	0	0	0	0	2
Drying	2	0	3	3	0	0	0	2	2
Packaging	2	0	3	3	0	0	0	0	0
Transportation	2	0	0	1	0	0	0	0	0
Distribution	2	0	0	0	0	0	0	0	0
Number of 3s	2	1	4	3	0	0	0	1	11

¹ 'Significant impact' was explicitly defined as 'impact the exposure unit has not coped with historically or is not able to cope with without an external support'.



drying (2), although the probability and prevalence of the hazards occurring should also be considered to determine their adaptation priority. All exposure units were thought to be at risk of medium impact

from at least one of the climate hazards considered. Warming is associated with the increase of temperature, less rainfall and less humidity.



Stakeholders assessment of the impact



Harvesting

Storage

Cooking

Drying



PROJECTED IMPLICATIONS OF CLIMATE HAZARDS

Insect Invasion

Pests cause considerable crop losses in the field and in storage in Senegal (Jalloh, 2013; Yaciuk & Yaciuk, 1980). Indeed, across Africa, it is estimated that each year insects destroy between 10% and 30% of all food produced, either pre- or post-harvest (Dhal-iwal et al., 2010; Oerke, 2006; Pimentel, 2007). Climate change can increase the risk of pest outbreaks, leading to greater yield losses with inherent negative consequences for food security in Africa (Jalloh, 2013; Nwilene et al., 2013). Dwindling and erratic rainfall patterns, rising air temperature and extreme heat brought on by climate change will have an impact on the spatial and temporal distribution and proliferation of insect populations. The number of pest generations, prompt immigration of new invasive species, and expansion of existing species' ranges are expected (Nwilene et al., 2013). This may alter host plant–insect interactions. Thus, it requires new integrated pest management strategies (Chen et al., 2005b). Furthermore, it is likely that insect management strategies developed in the past will also be affected by changes in climate; e.g., some traditional pest deterrents or conventional implementation may be rendered redundant as insect types and characteristics change (Gueye et al., 2013).

Heavy Rain

Heavy rains affected harvesting, transportation and storage of the industry. From 1970s to 1990s, crops have been ruined, communities and their infrastructure damaged, and supply chains disrupted by heavy



rains (Teng & Ni, 2016; World Food Programme, 2013). The annual average rainfall was 1,100 mm (1,123 mm in 1991, 935 mm in 1992, and 1,111 mm in 1993) (Herve, 1997). Heavy rain events are only set to increase in Senegal with climate change (Braman et al., 2013). Combined with other effects of climate change, sudden heavy rainfall could cause an increase in diseases and pests that farmers in those areas are not adapted to, exacerbate erosion, trigger flooding, and damage structures especially in hither to dryer areas (Jalloh, 2013).

Flooding

Risk of coastal flooding from storms is already very high in certain parts of Senegal (IPCC, n.d.); more than 50% of all the east littoral in Senegal is currently ranked as at high risk, and coastal flooding may affect more than two thirds of the coastline by 2080.



Several catastrophic floods have been observed in Senegal in recent years, (AFP, 2014; Braman et al., 2013; World Food Programme, 2013). Senegal records almost every year an intense decennial rain of unusual duration (Lo, 2013).

Floods cost FCFA 70 billion in Senegal between 2008 and 2012 (Global Facility for Disaster Reduction and Recovery, 2014). The impact of floods is amplified by deficiencies in town planning, and the absence of functional drainage for rainwater. Floods impact on the socio-economic living conditions of the population and provoke losses in human lives, and destroy the infrastructures and other goods (Teng & Ni, 2016), particularly in the agricultural sector (Holz, 2007). All industries can be affected by supply disruptions following floods when roads are blocked or damaged, including cereal milling industries. Flood affects all processes in the matrix, from crop harvesting to flour distribution.

Drought, Delayed Rain Season and Early Rain Season

Senegalese agriculture is highly vulnerable to rainfall variability with its reliance on rainfed agriculture (representing 97% of the total cropped area) (Jalloh, 2013). The climate condition of cereal production areas in Senegal varies depending on the crop source. There is change when the rainy season usually starts and dry season starts, it brings to the anomaly season and unseasonable rain distribution. This condition is already posing challenges for the cereal milling industry

(World Food Programme, 2013), but Senegal is projected to have increased rainfall variability and increased droughts due to climate change, especially in eastern Senegal (Jalloh, 2013). With most industrial activities concentrated in the Dakar Region, increased competition for water is expected among domestic, industrial, and agricultural uses. Average annual rainfall has diminished since 1970 (Jalloh, 2013) and is predicted to continue to diminish across Senegal, with aridity increasing not only in the north in particular (Ministère de l'Environnement et du Développement Durable, 2016), but also in the south, where the Casamance to Kolda could be at risk of drying up (Ministère de l'Environnement et de la Protection de la Nature, 2010).

Climate change scenarios have been worked out using the Regional Climate Model (RegCM), and have been improved and adapted for the study of the climate in Africa (Reg CM; Giogi et al., 1993 a et b; Pal et al., 2007). The reference period used for current climate change assessment is 1989-2005. With regard to future variability, the considered periods are: 2031-2050 (middle of the 21st century) and 2081-2100. Inter-annual variability of rainfall in June, July and August will increase for the period 2031-2050 with a succession of dry and surplus years making it difficult for any prediction on the configuration of rainfall and its impacts on the cultures in particular. Over the period 2081-2100, more significant rainfall deficits are envisaged in July (in the south of the country) and August, i.e. in rainy and cultural full season, in addition to negative rainfall anomalies throughout the rainy season. The projected rainfall decline by 2050



is 6% in St Louis, 7% in Matam, 10% in Dakar, 24% in Ziguinchor, and 23% in Kedougou (MPEN, 1999). Due to strong reduction of rain in the northern part of the country, the risks of edaphic drought will increase.

The productivity of agriculture will be strongly affected by drought, compounded by other climate change affects. Rising temperatures will increase the evapotranspiration demands of plants. The change in precipitation, associated with the increase in temperatures, will consequently change plant growth cycles, decrease agricultural yields, worsen land salinity, and increase crop predation.

Strong Winds

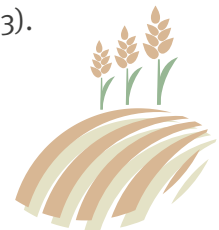
At farm-level, strong winds lead to wind erosion and reduced crop productivity or losses. Strong winds interfere, particularly near harvest, when portions of the crop can “fall over” due to strong wind. The fallen plants then begin to deteriorate in nutritive value, and the grain may begin to sprout or decay due to mold and bacteria. In addition, strong winds also may affect transportation and distribution process.

Warming (High Temperature)

An increase in temperatures of up to 3% is predicted in Senegal, with faster warming in the interior of Senegal than in coastal areas. Frequency of hot days/nights is expected to increase (Ministère de l'Environnement et de la Protection de la Nature, 2010).

The productivity of agriculture will be strongly affected by climate change whose effects will be added to the pressing constraints of the sector. The combined effect of the reduction of rains and an increase in temperature cause a reduction of germination and yields in grains. Decreased water availability will exacerbate the negative effects of warmer temperatures (Seck, Moussa Na Abou, Wade, & Thomas, 2005). Moreover, rising temperatures will increase the evapotranspiration demand of plants. The change in precipitation, associated with the increase in temperatures, has the consequence of changing plant growth cycles, creating drops in agricultural production, intensifying land salinity, and increasing crop predators. These changes, combined with population growth, could lead to a 30% reduction in per capita cereal production in 2025. However, this scenario is mitigated by the fact that in Senegal, maize and rice seem to be less negatively affected than other crops by the changing climate conditions, and their yields could potentially increase (Jalloh, 2013).

Higher temperatures will affect industrial operations, especially as warmer temperatures will adversely affect grain quality, both pre and post-harvest; for example, rising temperatures affect grain drying conditions. Warmer temperatures also increase risks of contamination in storage (Nwilene et al., 2013).





“The Senegalese government aims to integrate adaptation to climate change into industry policies, to encourage the development of management tools for climate risk across firms, and assess industry needs for information...”





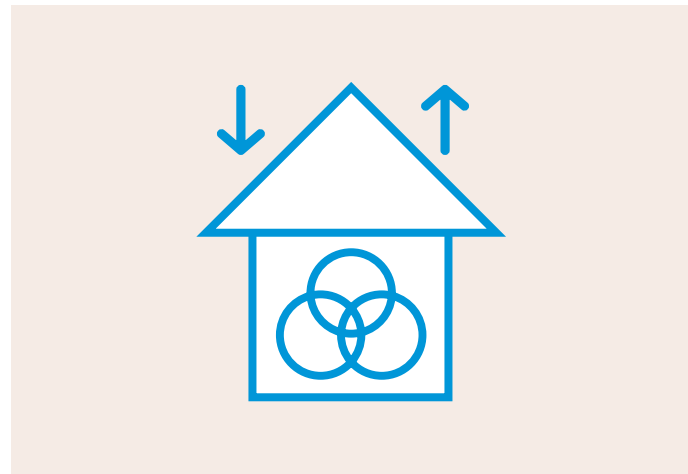
ADAPTATION OPTIONS FOR THE SENEGAL CEREAL MILLING INDUSTRY

Cropping

The farmers' choice of adequate crops, cropping systems, sowing dates, and harvest timing can be an important adaptation strategy to climate change. Water conservation is also pertinent to adaptation in Senegal. In irrigation areas especially, maintaining and updating irrigation equipment is critical. Moreover, increased access to appropriate machines and tools of varying scales will reduce processing time, labor, and food losses. The World Bank and the Consultative Group on Agricultural Research are supporting farmers to adopt 'climate-smart' techniques for cereal cropping, such as implementing agroforestry, trialling drought-tolerant crops, and using soil conservation techniques (Bobo, 2015; CGIAR, 2016).

Harvest and Storage

Increasing the knowledge of industry actors on proper use of improved post-harvest storage technologies will have an impact on the ability to reduce food losses. Good post-harvest handling and management practices extend from the field to the storage environment. Capacity needs to be increased on: correct harvest timing; maintenance and protection of the site and storage environment from pests and the weather (controlling grain and air moisture); basic hygiene through thermal disinfestation by solar heat or treatment with traditional additives; and commodity management (cleaning and drying of appropriate packaging facilities) using her-



metic storage (pits or metal drums) or treatment with natural and synthetic insecticides/pesticides (Hodges, Bernard, & Rembold, 2014; Nwilene et al., 2013).

Cooking and Drying

If the industry is going to create if value-added products like biscuits, pasta or noodles from the processed flour. Cooking pasta is related to the starch granules hydration (Fradique, et. al. 2010). In case of tortilla, the dough is made directly with the drying process which will be adjusted so that the correct moisture content for the dough remains in the flour. Measures are required to ensure correct temperature and humidity regulation at critical processing stages, so as to ensure consistency and quality in spite of any climatic fluctuations.



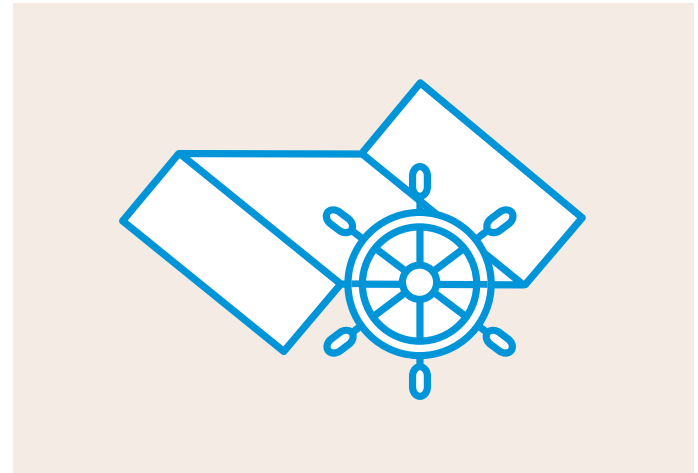


MITIGATION OPTIONS FOR THE SENEGAL CEREAL MILLING INDUSTRY

Mitigation Options On-Farm

At farm level, climate change mitigation can often be achieved as a result of implementing appropriate climate change adaptation strategies (Jalloh, 2013; Seck et al., 2005). Furthermore, implementing many of the landscape approaches for adaptation suggested in the previous section, for example, no-till farming along with application of crop residue mulch, manuring, legume-based complex rotations, certain agroforestry methods and integrated nutrient management, will result in fewer greenhouse gas emissions and also sequester carbon to an extent (Lal, 2010). Reducing the use of farm inputs such as fuel and fertilizer can particularly reduce the carbon footprint of the grain produced (Powlson, Stirling, Thierfelder, White, & Jat, 2016).

Domestic production of wheat would mitigate the carbon footprint of the wheat flour produced in Senegal, whilst diversifying farmers' crop portfolios (Bassi, 2014); farmers in the Senegal River region could consider uptaking the durum wheat being developed by the Swedish University of Agricultural Sciences (SLU) and The International Center for Agricultural Research in the Dry Areas (ICARDA). Durum wheat is good to be sown after rice during the months of November and harvested in February. Durum wheat cultivars are believed to be well responded to the environment and tolerate the devastating effects of the changing climates (CGIAR, 2014)



Minimize Waste

Wastage can be minimised by redesigning points where it frequently occurs, especially by using best practice techniques for grain storage. In addition, recycling waste for soil conditioning can be another option to reduce the impact of GHG emission.

Optimize Use of Transport

Efficient use of lorries (i.e. at capacity) avoids unnecessary emissions generation. There are several ways to maximize fuel efficiency in the lorries. An after-market upgrade expert recommends modifications that make the lorries more fuel-efficient to keep them on the road longer. The lorries can use synthetic oil and high-capacity filters. It maintains its lubricating



properties longer, allowing the engine to do its work with less friction and less wear, especially in temperature extremes (Businessfleet, 2013).

Alternative Fuels

Small-scale millers could consider switching to alternative renewable energy sources such as solar and wind, although these technologies may not be affordable. Some large factories in other Senegal industry, however, are using recycled biomass fuels. Solar air heating technology can be used for grain drying in place of artificial sources.

Innovate and Maintain Milling Technologies

Climate change mitigation becomes increasingly important at the point of processing. Energy efficiency

and low carbon energy sources are key to reducing emissions, and can lead to cost savings, as well as additional benefits such as lowered pollution levels.

Energy Experts International B.V. (Steerneman, 2013) recommend making energy saving measures for the following grain mill processes:

- Hot water and steam boilers (see Table 2&3)
- Compressed air
- Lighting
- HVAC installations
- Buildings
- Electro motors
- Production – Heating water for humidification – Use air emissions of cyclones of the mills – Optimization flour drying – Optimization blower transport

Table 2. Low Cost/ Shorter Term Measures for Boilers (Steerneman, 2013)

Energy Saving Opportunity	Action to Check
1. Reduce excess combustion air to minimum	1. CO ₂ /O ₂ measurement
2. Maximise completeness of combustion	2. Soot/CO measurement
3. Maintain boiler cleanliness (soot/scale)	3. Monitor for rise in flue gas temperature
4. Repair (replace) boiler insulation	4. Periodic inspection of boiler insulation condition
5. Insulate feedwater tank and cover tank	5. Check possible feedwater temperature losses
6. Insulate condensate return lines	6. Check possible heat loss from condensate return lines
7. Optimise quality of make-up water and feedwater	7. Monitor quality of make-up water and feedwater: hardness, acidity, O ₂



8. Minimise blowdown	8a. Monitor concentration of dissolved solids in boiler water 8b. Improve blowdown controls
9. Maintain nozzles, grates, fuel supply pressure/temperature at manufactures' specifications	9a. Ensure specifications are available and in use. 9b. Regular check and resetting/maintenance
10. Maximise combustion air temperature	10. Draw air from highest point in boilerhouse
11. Reduce steam pressure where it exceeds system/process requirements	11. Check system/process needs; adjust controls
12. Repair leaks in steam pipework	12. Install duct from combustion air intake to higher parts of room
13. Install an automated gas leakage detector	
14. Repair leaks in steam pipework	

Table 3. Higher Cost/ Longer Term Measures for Boilers (Steerneman, 2013)

Energy Saving Opportunity	Action to Check
1. For rapidly varying demand, convert one or more boilers to live accumulator (buffer tank)	1. Monitor/evaluate demand change patterns
2. Alter controls to 'High-Low-Off' or 'Modulating-Low-Off'	2. Monitor/evaluate demand change patterns
3. Install flash steam heat recovery	3. Consider in large capacity situations with high (continuous/frequent) blowdown
4. Improve combustion controls	4a. Provide adequate heat input to meet demand 4b. Minimise fuel/pollution 4c. Protect personnel/equipment
5. Waste heat recovery	5a. Economizer 5b. Air heater (recuperator)
6. Install boiler blowdown heat recovery	6. Consider in large capacity situations with high (continuous/frequent) blowdown
7. Use process integration	7. Couple process units that have significantly different heat requirements (i.e. low-pressure steam leaving a high-pressure steam consuming production process can be used for a process requiring low-pressure steam)



CONCLUSION: RECOMMENDATIONS

There are many processes along the cereal milling industry value chain that are vulnerable to climate change. To support adaptation and mitigation for the industry mentioned, Dr Fatou Lo Planchon (Lo Planchon, 2014) recommends the following:

1. Integrate adaptation to climate change into sector policies

Specific objectives:

- Integrate climate change mitigation and adaptation in the development sector policies of Senegal, focussing on energy, agriculture, water, and industry sectors.

2. Carry out an environmental assessment of the Emerging Senegal Plan (PSE) and integrate climate risk assessment in the different components of the PSE

Specific objectives:

- Implement a transversal strategy of co-construction to reinforce the robustness of PSE development options.
- Strengthen the institutional capacity of PSE to take into account and ensure the environmental monitoring of the project.
- Be consistent with the Environment Code of Senegal.
- Have strategic environmental governance tools incorporating variability and climate change in projects.

3. Encourage development of management tools for climate risk across firms.

Specific objectives:

- Encourage the transfer of knowledge and innovation and exploit the potential of clean technologies to create wealth.
- Study small and medium-sized enterprises' knowledge, attitudes and practices of face coping with climate change.
- Take into account very small processing businesses of the informal sector.
- Classify SMEs according to their geographical location.

4. Assess industry needs for information about future climate and organize activities for collecting, producing and disseminating for a better understanding of the future effects of climate change

Specific objectives:

- Have a reliable database on climate variability to reduce the impacts of climate change.
- Assess risks to be reduced and identify advantageous opportunities for adaptation
- Promote and facilitate the implementation of the ACC2013 Declaration (Africa Climate Conference, 2013) to enhance climate research for development.
- Facilitate the development of collaborative platform between research institutes and businesses.

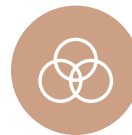


5. Perform vulnerability studies to fine scales to take into account the spatial dimension of the territory within which a strong synergy is built between the socio-economic and natural systems.

Specific objectives:

- Have infrastructures for observation and experimentation to produce pertinent data and indicators which will be integrated into local planning documents.

- Improve the knowledge on the vulnerability of territories to climate risks.
- Map vulnerable areas and target the most relevant types of vulnerability.
- Promote shared governance of climate and development challenges.





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This report examines Senegal's cereal milling industry: identifying the impacts of climate change on the cereal milling value chain and suggesting options for climate change adaptation and mitigation.



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Vienna International Centre · P.O. Box 300 · 1400 Vienna · Austria
Tel.: (+43-1) 26026-0 · environment@unido.org
www.unido.org