



# FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative



## FEED THE FUTURE BUSINESS DRIVERS FOR FOOD SAFETY

Cooperative Agreement No. 720BFS19CA00001

### 100 AFFORDABLE FOOD SAFETY TECHNOLOGIES FOR GROWING FOOD BUSINESSES IN SENEGAL *Applicable in Other Countries*

March 2022



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## FOREWORD

Micro, small, and medium-sized businesses in emerging economies face numerous challenges before they turn a profit. Cash flow and inadequate capital are major issues for them. These financial barriers make it particularly difficult for businesses to consider and address food safety, food security, and food quality challenges. Yet very affordable technologies and practices exist that most companies can utilize without a major investment to improve their business operations and produce safer food for their clients (consumers).

This *100 Affordable Food Safety Technologies for Senegal Growing Food Businesses* manual was created for GFBs (growing food businesses) by Feed the Future Business Drivers for Food Safety (BD4FS), funded by USAID and implemented by Food Enterprise Solutions. This manual identifies affordable and readily available tools and techniques for safely processing, handling, transporting, and storing foods that growing food businesses GFBs in Senegal and beyond can adopt to protect consumers.

Food businesses that implement these affordable technologies can be important drivers of food safety while also improving their profitability and competitiveness in local and export markets. Getting safe, nutritious foods to local markets benefits consumers and the businesses along the supply chain.

## **LIST OF ACRONYMS**

CCP - Critical Control Point

COA - Certificate of Analysis

FAO - Food Agriculture Organization

FIFO - First in First Out

GAP - Good Agricultural Practices

GFB - Growing Food Business

GHP - Good Hygiene Practices

GMP - Good Manufacturing Practices

GPRS - General Pocket Radio Service

IGR – Insect Growth Regulator

LOTOTO - Log Out Tag-out Try out

LPG - Liquid Petroleum Gas

MHE - Material Handling Equipment

MSMEs - Micro, Small and Medium Enterprises

PPE - Personal Protective Equipment

PET - Polyethylene Terephthalate

PRPs - Prerequisite Programs

QR - Quick Response

RFID - Radio-frequency Identification

RMP - Risk Management Program

SOP - Standard Operating Procedure

SSC - Soluble Solids Content

UV-Light - Ultraviolet Light

WHO - World Health Organization

## INTRODUCTION

Food safety, food security, and food quality are challenges in Senegal despite efforts from the government to streamline policies, and aid from external groups to promote food safety. Foodborne illness resulting from inadequate food handling, processing, and storage remains a common occurrence. Through the Malabo declaration and *Programme d'Accélération de la Cadence de l'Agriculture Sénégalaise*, the government is focused on eliminating hunger and promoting food safety and security.

Food safety technologies are essential for effectively and efficiently producing and distributing quality foods. Growing scientific innovation in crop production has shown that technology and innovation work for the common good (FAO, 2015; FAO and WHO, 2006; Hussain et al., 2015). Postharvest technologies and practices are equally important for putting safe food products in the hands of consumers. By adopting practices and technologies that improve food safety, such as hygienic food handling practices and cold chain logistics, businesses can reduce the transmission of foodborne diseases and the associated malnutrition and death that result from consuming contaminated foods.

Embracing established food safety practices and technologies combined with using innovative techniques to adapt and tailor these to the local situation are key to improving food safety, quality, and security. Feed the Future Business Drivers for Food Safety (BD4FS), implemented by Food Enterprise Solutions (FES) and funded by USAID, works to identify practices and technologies that are relevant and applicable to Senegalese food businesses and documented them in this manual, *100 Affordable Food Safety Technologies for Senegal Growing Food Businesses*.

The technologies presented in this manual promote food safety and are readily adoptable by GFBs without heavy financial constraint. This manual intends to create awareness among business owners and food handlers so they can leverage these technologies to affordably improve food safety, and ideally promote these practices throughout the food business sector. By adopting these efficient and effective technologies, GFBs can improve their business operations and profitability while protecting consumers.

The 100 food safety technologies described herein are organized into the following seven categories:

1. Good agricultural practices and technologies
2. Manufacturing and food processing
3. Packaging and labeling
4. Shipping
5. Selling and traceability
6. Consuming
7. Waste and recycling

# CHAPTER ONE - GOOD AGRICULTURAL PRACTICES (GAP) AND TECHNOLOGIES

## 1.0 Introduction

Food safety measures start at the farm, the origin of food. Good Agricultural Practices (GAPs) are thus the initial stages of ensuring that food is safe. Technologies to reduce defects and postharvest losses are crucial in ensuring that consumers are purchasing high quality food products and that manufacturers maximize profits. Agricultural products are the raw materials for the processing and manufacturing industries.

## 1.1 Innovative harvest techniques

Foods that are harvested properly and in a way that maintains their freshness and reduces damage have a greater chance of reaching customers in good condition. This is particularly true for fruits and vegetables. Use of nets while harvesting is a technique that reduces damage and prevents contamination that might be introduced by birds.



## 1.2 Sorting sheds

After harvesting, farmers using “good agriculture practices” (GAPs) will sort and remove any product that is damaged or defective. These defects are introduced by birds, insects, or human activities. By sorting, defects are eliminated at the source.



## 1.3 Recycling packaging materials

Reusing, recycling, and sterilizing containers by planting vegetables in them is an innovation that requires low capital and little infrastructure. This is particularly useful in urban centers of developing countries that often have dense populations and limited space for agriculture.



## 1.4 Nut gatherer and harvester

Nut gathering roller machines have flexible wire loops that help pick nuts when they fall from the plant. It is an innovative technology that helps reduce physical hazards and doesn't damage the nuts.



### 1.5 Flying insect glue boards

This technology uses UV light tubes to lure flying insects which are then trapped by the sticky adhesive. Upon contact with the adhesive surface (glue board), the insects are attached and restrained. It is advantageous because restrained insects remain in the unit and are easily collected for disposal.



### 1.6 Cordless rechargeable electric gadget for flying insects

A rechargeable handheld gadget designed to kill flying insects is an existing technology that can be utilized to kill houseflies and other insects that commonly contaminate products. This gadget offers rapid action by striking down insects with an electric current upon pressing the button.



### 1.7 Glue traps

Glue traps with adhesives can be used to trap both insects and rodents on farms.



### 1.8 Insect growth regulators-based pesticide

Hormone-induced insecticides can be used to help in pest control on farms. They are non-toxic and not harmful to humans. Insect Growth Regulators (IGR), control the mating process and prevent pests from reaching maturity, making them infertile (Meenu and Verma, 2020).



# CHAPTER TWO - MANUFACTURING AND FOOD PROCESSING

## 2.0 Introduction

Manufacturing refers to the process of converting and transforming agricultural raw materials into finished food products that meet manufacturers' specifications and are safe to consume.

## 2.1 Magnets

Vessels and mixers used in food processing are made up of stainless steel because of suitability and its resistance to rust. Magnets can be used as a preventative tool in production processes to mitigate against physical hazards being introduced into foods. They are incorporated in the design of the mixers and help in removing metallic solid contaminants before they reach the food product.



## 2.2 Manufacturing and grain sieves

Using a combination of sieves that sort for the desired granularity ensures the right size and grade of the homogenous blend and mixture is obtained. The sieves also help in separating the juice, syrup, or liquid extract from solid matter.

### a) *Manufacturing sieves/process sieve*

Manufacturing or process sieves are used within a processing unit to select the right grade of blend and to eliminate physical hazards. These sieves are made in the form of rollers, fabric, and mesh gauges. Some of the sieves are magnetic and can be used to eliminate magnetic contaminants from food during processing.



### b) *Grain sieves*

Grain sieves help eliminate other contaminants that may have been picked during harvesting. This includes stones, defective grade, plant cover, and different variants of cereals.

## 2.3 PVC curtains for food processing facilities

PVC curtains are convenient, durable, and provide a strong barrier against pests and contaminants. They mitigate against flying insects from entering food processing units, preventing physical and biological contamination. Additionally, they allow natural light into the processing facilities.



## 2.4 Portable handheld infrared thermometer gun

Heating, cooking, cooling, and storage are temperature-specific stages within food processing that need to be monitored to achieve the desired stability and shelf life of the finished food product. The incorporation of an infrared thermometer in the process promotes food safety as the temperature can be checked at different points in the mixer with no physical interaction between the food product and the measuring equipment. This eliminates sources of contamination and damage.



## 2.5 Personal protective equipment (PPE)

Food handlers understand the role they play in terms of promoting food safety. Use of PPE such as aprons, overalls, gloves, hairnets, safety shoes, and gumboots, is a simple and important action that food handlers can take to reduce food contamination and protect consumers. These PPE should not replace handwashing practices.



## 2.6 Face shields

Face shields help in preventing harmful microorganisms from entering the eyes. They also prevent the transfer of cough aerosol droplets from the food handler to the food. This is a key PPE during COVID-19 as face shields also reduce the transfer of aerosol droplets from one individual to another.



## 2.7 Andon light and signal innovation

This defect detection mechanism emits a combination of lights and sound buzzers whenever a defect is realized within the food processing operation. It prevents food products that don't meet quality parameters from reaching the market. The mechanism detects defects ranging from underfills, poor pack dressing, and poor sealing that may result in biological, chemical, and physical hazards in food.



## 2.8 Sealing machines

### a) Heat sealing machine

These hand-operated machines used heat to seal pouches, sachets, and polyflex material. They have a hot plate where the packaging material is placed and hand-pressed for sealing. This technology replaces the traditional method of sealing that used candles.



### b) Cold sealing machine

Cold sealing requires pressure to seal packing. A food-grade, pressure-sensitive adhesive is applied on the packaging material, and it is pressed against a paper board for sealing. This is a simple, fast, and cost-efficient method of sealing as it is not temperature dependent.



## 2.9 Time buzzers

Time buzzers are incorporated into mixers and vessels to assist in regulating timing within food processing. They produce alerts or alarms when a given process and condition has been attained at a specified time within the process. They help in controlling and monitoring the critical control point (CCP). This technology reduces the risks of overcooking or overprocessing, thereby mitigating food hazards.



## 2.10 Standard Operating Procedures (SOPs)

SOPs are written sequences of procedures that are used to standardize operations. They provide a set of conditions to be adhered to and prevent things from going wrong within the process.



## 2.11 Biosensors

Biosensors have been embraced in food manufacturing and processing industries. They are used to analyze nutrients and detect hazards in food processes. When suspensions and product variations are detected, they are rolled out of the conveyor. Biosensors are also used in analyzing nutrient levels in fruit juices to ensure they are within the stipulated range. They have the advantage of target specificity, fast response time, and are easily electronically integrated.



## 2.12 Metal detectors

Preventive measures must be deployed to avoid food contaminations that cause foodborne illness. Metal detectors can be employed in all stages of food inspection from raw material, processing, packaging, and storage to removing physical contaminants. They help manufacturers achieve compliance, minimize the risk of product recalls and withdrawals, and reduce downtime. Handheld devices make detection and inspection easy.



## 2.13 Tamper proof seals

Tamper-proof seals prevent food product contamination after packaging and before they reach consumers. They protect the integrity of food and improve consumer confidence in the product.



## 2.14 Automated washing aids

Food processing factories have automated rotating brushes that are connected to the conveyor and enhance the washing of the food products from the farm. The washing process eliminates any chemical, physical, and biological hazards.



## 2.15 LOTOTO

Log out, tag out, and try out (LOTOTO) are safety procedures used in situations where inspection personnel may be exposed to hazardous energy. These energy sources could include electrical, mechanical, hydraulic, pneumatic, chemical, radiation, and thermal hazards.



## 2.16 Certificate of Analysis (COAs) or Certificate of Conformance (COC)

A Certificate of Analysis (COA) or Certificate of Conformance (COC) is a document from the supplier that confirms that the ingredient meets specifications. It provides results for identification and quality testing performed by the manufacturer for a given batch. COAs and COCs should be rechecked before delivery to ensure the lot number matches with the one being received or delivered. They confirm to the consumer that the food product has been tested and approved for use. COAs and COCs are system generated and accompany the food product (Catherine *at al.*, 2017 Certificate of analysis: A challenge to interpret).<sup>28</sup>



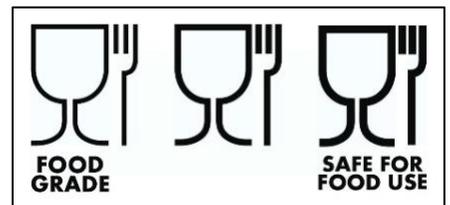
## 2.17 Preventive maintenance

Food processing vessels and mixers require maintenance to mitigate machine failure. Preventive maintenance is aimed at restoring equipment reliability by replacing worn-out parts before failure. If these measures are not taken, food processing hazards get introduced.



## 2.18 Food-grade material and components

A food contact surface is any surface that may come into direct contact with food. Food contact surfaces are made of food-safe materials designed to withstand the environment where they will be used. This includes exposure to cleaning compounds, sanitizing agents, and cleaning procedures. Lubricants and other non-food compounds must be identified in all areas of the facility. Chemicals used for cleaning and disinfecting must be suitable and appropriate for food contact surfaces and must be acceptable by legislation such as FDA (Kamboj *et al.*, 2020).



## 2.19 Stamp coding

Coding refers to the process of affixing unique numbers and codes to a product for traceability, product recall, and withdrawal. The use of stamp technology has made it easy compared to the alternative inkjet machine that requires initial investments to purchase a conveyer belt and electrical connection.



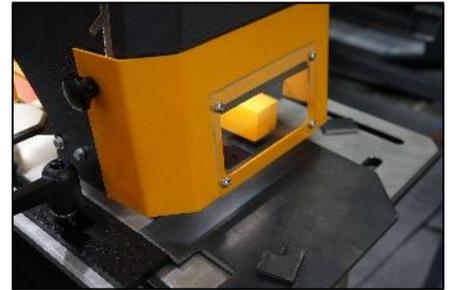
## 2.20 Food safety programs

Food handlers and food manufacturing companies are now incorporating food safety pictograms and visual management policies to help in standardizing operations, promoting a food safety culture, and increasing consumer confidence. Incorporation of kaizen practices and 5s principles in food industries improve safety and hygiene throughout the food supply chain.



## 2.21 Machine guarding

Processing machines and farm implements expose the user to the hazard of interacting with the moving parts of the machine. This unwanted interaction may injure or cause death to the operator. There is also risk of food contamination if an operator is cut and their tissue gets mixed with food. Machine guarding is a safety feature on or around manufacturing or other engineering equipment. They consist of a shield or device that covers hazardous areas of a machine to prevent contact with body parts or to control hazards like chips or sparks from exiting the machine.



## 2.22 Sharing safety documents

Technical data sheets and material safety data sheets (MSDSs) of raw materials, intermediate products, and finished products should be provided to personnel who may come into contact with materials or products that pose potential hazards. These documents provide information on proper product handling, storage, and safety protocols. The MSDSs also state what should be done if the chemical is ingested or makes contact with a person's skin or eyes. These documents are a crucial component of the occupational health and safety requirements of a food company. To ensure legal compliance, MSDSs should be available in every food business at the point where the stipulated chemical is used or where it is easily accessible. MSDSs also play an important part in a food safety HACCP system.



## 2.23 Just in time and make to order technique

Food security and control of food inventory are a growing concern for food dealers, restaurants, and other players in the food industry. Maintaining a large inventory and stock of food results in increased cost of storage space, preservation, disposal, and food security issues. Because of these costs, most food dealers make and process food based on the order quantities and timing of the request. This approach helps mitigate food hazards that are associated with longer-term food storage, including increased handling.



## 2.24 Inventory control

Batch numbers and lot numbers help in traceability and inventory control. These two unique numeric codes help in denoting different times of production, receipt, and storage. First in First out (FIFO) is applied where first produced and stored food products are sold and issued out first. This approach helps prevent products from going bad before they are sold or consumed.



## 2.25 Handheld refractometer

Sugars are the major soluble solids in fruit juices and therefore soluble solids content (SSC) can be used as an estimate of sweetness. A hand-held refractometer is used outdoors to measure % SSC (equivalent degrees Brix for sugar solutions) in a small sample of fruit juice. The parameter is affected by temperature and must be used at a specific temperature.



## 2.26 Using a firmness tester

Penetrometers are used to obtain the degree of softness or firmness of fruits. This is an important quality parameter because fruit hardness helps in determining fruit ripeness. The penetrometer obtains fruit hardness by accurately measuring the force required to push a plunger tip into fruits. The force measurement gives the necessary information for farmers, growers, and fruit quality experts to determine the best picking time and to monitor the fruit ripening process and softening during storage (STEP System GmbH).



## 2.27 Potable pH meters and litmus papers

Acidity, or pH, is a critical parameter in the biochemistry field because most organisms and chemical species operate within a specified pH range. With the invention of pH meters and litmus papers, determination and analysis of food samples such as water, juice, and milk can be undertaken easily and any deviation noted.



## 2.28 Protection of food recipes and formulations

Mobile software applications coupled with good information technology (IT) practices make it possible for manufacturers to accurately follow food recipes and formulation, hence protecting the consumers. Embracing good IT practices and data protection policies protect food recipes and formulation from interference.



## 2.29 Training

BD4FS partnered with Virginia Tech University, USA, to engage Senegalese youth in developing a food safety mobile learning application. There are two applications in development that are aimed at educating and training fishermen and farmers in agribusiness on the importance of food safety throughout the supply chain.

### a) *Samba the fisherman*

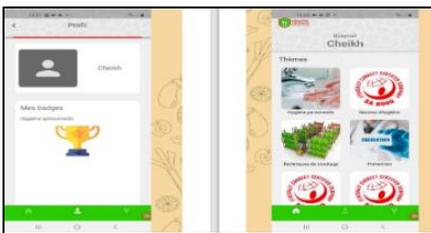
The “Samba the fishermen” app is an educational game based on storytelling, with role-playing scenarios. It will enhance awareness of the challenges being faced by fishermen in the fishing industry. The story is told through a character known as young Samba, who is interested in joining agribusiness and following the footsteps of his father. The game will allow participants to acquire food safety knowledge at each stage of the food and supply chain (harvest, landing, processing, and local and regional transport) which will then be followed by a quiz section. The Samba application will be played online allowing participants to compare their scores and challenge each other.



### b) *SSA Quiz*

The Sécurité Sanitaire des Aliments (SSA) game aims to raise awareness of agricultural entrepreneurs on:

- Good hygiene practices.
- How to anticipate and control food safety hazards.
- The importance of preserving the integrity of the food chain.
- How to ensure that consumers have access to safe food.



The game will be based on fictitious situations but representative of real situations. Thus, the rules of hygiene become concrete and practical.

The SSA Quiz trains the user on different food safety topics. Each topic has five quizzes (15 questions). For each quiz, the user watches a short instructional video before answering the questions.

# CHAPTER THREE - PACKAGING AND LABELING

## 3.0 Introduction

Packaging material provides an enclosure that protects food from contaminants and other hazards that may render food unsafe. Innovators in the packaging industry have come up with different products that promote food safety, present food in visually appealing ways, and facilitate proper use.

## 3.1 Flexible packaging

Food safety requires protective materials and processes working in concert to keep food fresh inside and guard against outside contaminants. Flexible packaging provides food manufacturers and handlers with a variety of choices that work for different product types, such as dry foods, oily foods, and beverages. Varying requirements such as storage temperature, sterilization and transportation conditions help define what each food product needs. Flexible packaging utilizes a combination of materials that are effective, economical, dependable, and that ensure food safety. (CDF mindful packaging, 2020)



## 3.2 Kitchen film wraps

Unpackaged food that is open to the air is prone to contamination and foodborne illness. The use of kitchen film reduces the risk of foreign agents interacting with food.



## 3.3 Silicone vinyl pouches

Packaging food in silicone vinyl pouches for refrigeration protects food from going bad and becoming contaminated with microorganisms. Silicon vinyl zipper pouches prevent oxygen, light, and humidity from accessing the food. These factors can affect food shelf life, reducing their viability and safety.



## 3.4 Aluminum foil

In addition to providing a protective covering, aluminum foil can be used for quick and easy cold storage, and for heating food.



### 3.5 Perforated boxes

Perforated corrugated boxes and polythene bags are utilized in the horticultural sector for fruit and vegetable storage and transportation. Horticultural products are sensitive to moisture and humidity. Perforated containers help in regulating moisture by allowing air in and out.



### 3.6 Nets

The use of nets in the selling of fruits and vegetables allows airflow, is visually appealing to customers, and can be cost-effective for packaging.



### 3.7 Cushioning materials

Use of cushioning material for storage and transport of fresh produce helps prevent damage. This is particularly important with an increase in global trade where produce is transported over far distances and subject to kinetic energy impact that can cause bruising during transportation (Dubey and Mishra, 2018).



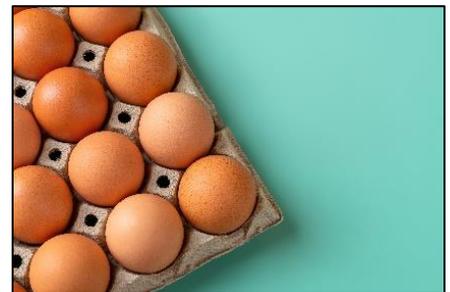
### 3.8 Polystyrene trays

Polystyrene trays are used in the transportation and storage of fruits and vegetables to protect them from damage. Inert packaging material such as polystyrene, which does not transfer chemicals to food, has gained recognition for maintaining food safety and protecting human health.



### 3.9 Biodegradable food trays

The use of biodegradable corrugated trays and containers is an eco-friendly and safe option for packing, storage, and transport of produce. They are easy to reuse and recycle, have minimal impact on the environment, and do not contain chemicals that might contaminate food. They are made from paper pulp, cardboard, and carbonaceous remains of fruits such as pineapple.



### 3.10 Disposable cups

The use of disposable cups for tea, coffee, and juice by vendors increases the level of hygiene and reduces the risk of contamination when used in place of reusable cups.



### 3.11 Transparent packaging

Portable and perforated packaging for storage of vegetables and fruits can help prevent postharvest losses.



### 3.12 Modified atmosphere packaging

Modified atmosphere packaging (MAP) is defined as “the packaging of a perishable product in an atmosphere which has been modified so that its composition is other than that of air.” MAP foods are constantly changing due to chemical reactions and microbial activity (Mullan, 2003). Gas exchange between the pack headspace and the external environment may also occur because of permeation across the packaging material. Packing foods in a modified atmosphere can offer extended shelf life and improved product presentation in a convenient container, making the product more attractive to the retail customer.



### 3.13 Cartons with transparent windows

In response to the growing desire by customers to see the contents of a package before purchasing foods, producers can use cartons with transparent windows. This innovation allows customers to see the product while keeping food safe in an enclosed package.



### 3.14 Gunny packaging

Gunny packaging has long been used in the transportation and storage of cereals and produce. With the ban on single-use polythene bags, many investors, GFBs, and private sectors are working on adapting and improving gunny bag packaging for additional uses.



### 3.15 Proper Labeling

Proper labeling is used to identify the food product, ingredients, and shelf life. This allows consumers to select products that align with their health goals and beliefs, and to avoid products that contain ingredients to which they are allergic. Proper food labeling also eliminates food fraud.



### 3.16 Heat gun sealer for shrink wrap and labeling

Heat guns are a simple to use technology that have variable temperature control and blow hot air onto a flexible film label to attach it tightly to the product. This shrink-wrapping technique can also be used to wrap and compact products to bundle them in desired quantities (e.g., dozens). This innovation prevents damage, helps keep items together during transportation, and protects them from dust and dirt.



### 3.17 Self-sticking labels

The use of self-adhesive labels has made it possible for information related to the food product to be conveyed to the consumers. Self-sticking labels have made work easier and saved on packaging costs. These labels are waxed and waterproof hence they can withstand a range of temperature and humidity conditions.



# CHAPTER FOUR - TRANSPORTATION AND SHIPPING

## 4.0 Introduction

Transportation, shipping, and logistics are vital in making sure food products reach consumers at the right time. This helps farmers and agri-businesses stay competitive by reducing uncertainties in the supply chain. Supply chain logistics has undergone a massive transformation in ensuring that products get to the consumer at the right time, right quality, right quantity, and right price.

## 4.1 Innovative Trolleys

Trolleys and carts are used in the transportation of food products from the farm. These carts can be pulled by motorbikes or by hand.



## 4.2 Impervious covers while transporting food products

The use of canvas covers on trucks while transporting food products prevents them from physical contamination by dust and flying insects that may render food harmful.



## 4.3 Flexible transportation modes

The quadricycle, hand-driven with attached tray trolleys, helps in transporting fresh fruits and vegetables to the market. Because of their open display of products, they can also be used for vending.



## 4.4 Palletization of food products

The use of pallets in the transportation of food products eliminates damages and minimizes logistical constraints by creating ample space for loading. Palletization saves on time as loading and offloading by Material Handling Equipment (MHE) is simplified.



## 4.5 Cooler boxes

Cooler boxes can be used to carry food samples by providing a controlled temperature for preservation.



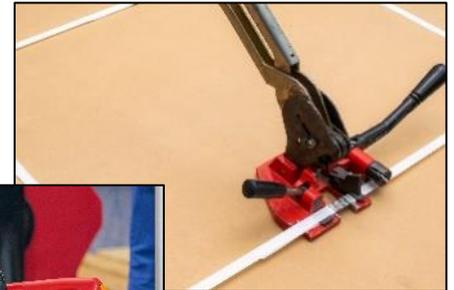
## 4.6 Adherence to stacking requirements

Food items need to be packed and arranged properly for storage and transportation. This allows food products to reach consumers in good condition and reduces damage to containers. To be effective, secondary packaging materials must contain instructions limiting the number of containers and boxes to be stacked on each other.



## 4.7 Strapping and fall-proof

Strapping helps compact and secure secondary packaging to the pallet. The strapping creates a fall-proof mechanism that prevents product damage and loss during transportation. The strapping devices are semi-automatic and handheld making them easy to use.



## 4.8 Plastic and wooden crates

Crates are used in storing and transporting agricultural products from the farm.

### a) *Plastic crates.*

Plastic crates are preferred because they are light in weight, mechanically strong, and available in many designs.



### b) *Wooden crates*

Wooden crates are used for heavy agricultural food products and keep food products safe before they reach the consumer.



#### 4.9 Styrofoam and gel packs/blocks

Styrofoam and cold gel packs are a cooling technique that can be used for storage and preservation of fish and seafood before offloading them at the shores.



#### 4.10 Controlled freezing point storage

Controlled freezing-point storage is a new refrigeration technique. The focal point of the technique is to store fresh produce at a non-freezing temperature zone. The technology is more efficient than the older refrigeration technique. Non-freezing temperature zone is defined between the freezing point of water (0°C) and that of the individual material (Guo *et al.*, 1990).



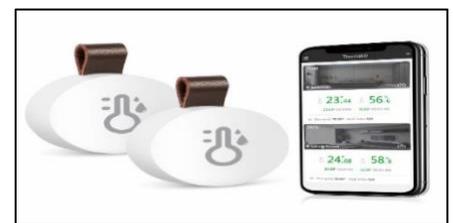
#### 4.11 GPRS and food trucking

General Packet Radio Service (GPRS) uses mobile applications that are connected to chips that help in locating and tracking food products during transit.



#### 4.12 Bluetooth-enabled temperature monitoring device

Bluetooth is a wireless technology that uses a radio signal to connect devices. Bluetooth low energy loggers are used for temperature monitoring and transmitting real-time data and temperature fluctuations when food products are under temperature control on the high seas. It is also used to regulate and monitor temperature and humidity inside warehouses.



### 4.13 RFID

Radiofrequency identification (RFID) systems have three basic components: tags, readers, and a host computer. RFID tags contain tiny semiconductor chips and miniaturized antennas inside the packaging. Some RFID tags look like paper labels and are applied to boxes and packaging. Each tag is programmed with a unique identifier that allows wireless tracking of the object to which the tag is fastened. The chips used in RFID tags can hold a large amount of data or information such as serial numbers, time stamps, configuration instructions, technical data, medical records, and travel history. (Summer, 2005 edition of TechBeat News magazine)



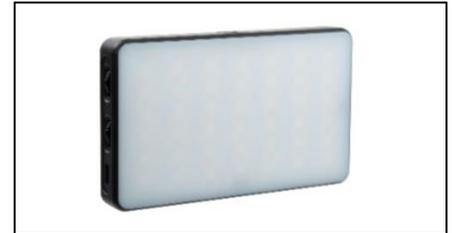
# CHAPTER FIVE - SELLING AND TRACEABILITY

## 5.0 Introduction

Traceability is the ability to use unique codes (batch or lot numbers) to trace and follow the food, feed, food-producing animal, or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing, and distribution. It links all business processes from the beginning of a supply chain to the final consumer (Food Standards Agency, 2002).

## 5.1 LED lighting

LED technology has revolutionized lighting and enhanced food safety because it does not interfere with food composition. Portable LED lights allow SME vendors to conduct their business at night, expanding their operating activities and earning potential. LED lights adhere to HACCP guidelines and are useful in restaurants and supermarkets.



## 5.2 Renewable energy

Many Senegalese food dealers and vendors have adopted the use of renewable solar energy as a backup energy source or a supplement for power deficiency. This technology can be used for consistent cooling and lighting during evening hours. It also provides health benefits for food vendors and customers by eliminating the need for candles and lamps at night markets that produce toxic materials (carbon monoxide, soot, melted wax).



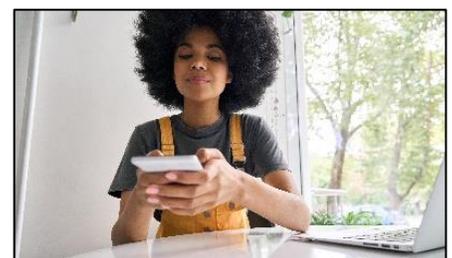
## 5.3 Barcodes

The use of barcodes has enhanced product identification and traceability by making it easier to identify and track items. The use of barcodes has improved food safety, compliance, and business process improvements.



## 5.4 QR scan codes

QR scan codes are emerging as a useful tool to improve traceability of products. Suitable software can scan the QR codes to keep track and identify food products throughout the food chain.



## 5.5 Combination of RFID, QR, and Barcodes

A combination of RFID, QR codes, and barcodes has improved the traceability of food products at different points of processing, storage, transportation, and point of sale to end consumers.



# CHAPTER SIX - FOOD PREPARATION AND CONSUMPTION

## 6.0 Introduction

Finished food products are prepared for consumption after processing, packing, and transport. Implementing good food safety practices remains critical during preparation to ensure that foods are handled and cooked using methods that minimize contamination and risks of foodborne illness.

### 6.1 Tongs and tweezers

Many food handlers and vendors, particularly roadside vendors selling food products such as corn, fish, meat, and cassava, use tongs and tweezers while handling food as opposed to the small pieces of paper. This practice eliminates direct contact of hands with foods and reduces the risk of contamination.



### 6.2 LPG by GFBs

Food vendors have welcomed the use of safer fuel in cooking, and many are using LPG (liquefied petroleum gas) as opposed to wood and coal. In Senegal, LPG has become the principal cooking fuel for most households. This cleaner fuel option coupled with good hygiene standards provide food products that are safe, devoid of smoke, and absent of contamination from small pieces of charcoal and wood that compromise food safety.



### 6.3 Solar cooking basket

Solar cooking baskets use locally available resources such as bamboo and sisal baskets lined with photochromatic material which converts these baskets into cookers. This technology has been adopted by women and youth in Casamance, the southernmost region of Senegal.



### 6.4 Commercial potato chip cutter

Potato chips have gained recognition in modern cities and towns topping the list of most consumed food. Being a lucrative business, most of the food handlers and GFBs in the potato processing industry have welcomed machinery that saves time and makes work easier.



## 6.5 Microwaves

Microwave technology is beneficial for quickly cooking food and keeping it at a constant temperature suitable for consumption. Hot foods are more easily digested and when heated to the proper temperature, bacteria and other contaminants are killed, reducing the incidence of foodborne illness.



## 6.6 Pressure-cooking

A pressure cooker uses the technology of trapping steam generated by the food product being heated. As steam builds, pressure is increased driving the boiling point of water to a higher temperature. This higher temperature cooks food faster.



## 6.7 Air fryers

Air fryers ensure proper heat distribution in cooked foods and, in contrast to traditional frying techniques, reduce the amount of cooking oil required. They work by circulating hot air around the food in a very similar way to convection ovens.



## 6.8 Solar driers

Drying is a frequently used method for food preservation: it helps prevent growth of microorganisms and reduces deterioration by removing moisture. In addition, food drying provides numerous benefits, such as the formation of desirable texture and physical properties, extending shelf life, and minimizing packaging, storage, and transportation costs. The use of solar driers in combination with hot air makes the process faster and more efficient.



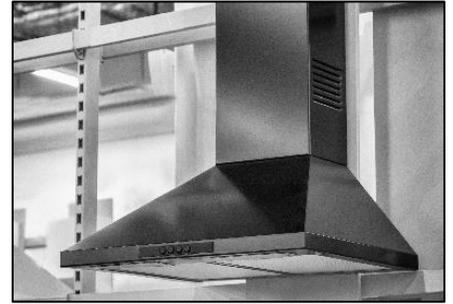
## 6.9 Defrosting trays

When meat products are preserved in the freezer, they must be defrosted to enable proper preparation and cooking. Rust-resistant metal defrosting trays make this process easier because they are good heat conductors while maintaining quality of the food products.



## 6.10 Heavy gauge hood chimney

Food handlers that roast or deep-fry foods need to protect themselves and staff from excessive smoke associated with these methods. The smoke generated may affect food safety as well as reduce visibility in the kitchen, creating an unsafe work environment. The use of a heavy gauge hood chimney can extract the smoke and reduce hazards to food and food handlers.



## 6.11 Electric boiler / tea urn

Electric boilers, or tea urns, are thermo-flasks for hot water and other beverages. When the water reaches the highest degree, the boiler automatically keeps the contents warm and re-boils if the temperature drops below 85°C.



## 6.12 Strainers

Strainers are a readily available and affordable tool that can be used to clean fruits at the sink. Clean water from the sink tap is directed to the strainer basin where the fruits are washed and the water from the washed fruits finds its way through the sieve-like openings.



## 6.13 Manual fruit juice squeezer

Fruit juice squeezers are simple and easy to use. They help in obtaining juice from fruits in a simple and fast manner, and by eliminating hand contact with the fruit flesh and juice, they reduce the risk of contamination.



## 6.14 Meat mincer

Meat mincer machines help in breaking large meat pieces into small pieces which can be easily cooked and made into other food products such as samosa, sausages, and pies. When properly cleaned and maintained, they can safely process meats to desired consistency.



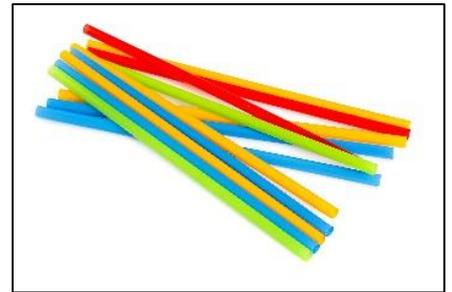
### 6.15 Disposable plastic cutlery

With growing trends in families opting to have their meals outside their homes, the use of disposable plastic cutlery has increased. Single-use cutlery eliminates the risk of contamination from improperly washed utensils that pass from one user to the next.



### 6.16 Drinking aids

When vendors provide complimentary food-related products such as straws, they can help reduce contamination of beverages and soups by minimizing contact with hands. Straws have found their use in milk, juice, and soup.



### 6.17 Vacuum plastic sealing machine

Vacuum packaging helps in prolonging the shelf life of food products by removing most of the oxygen prior to sealing the packaging. Vacuum packaging reduces oxidation that can be caused by excessive moist air, helps preserve food flavor and overall quality, and inhibits the growth of aerobic microorganisms.



### 6.18 Airtight containers

Airtight containers are used in the refrigeration and storage of food. These containers help in keeping food free from moisture and oxygen that can spoil food.



### 6.19 Water treatment tablets

Access to safe drinking water is a challenge to many Senegalese households. Chlorine tablets kill microorganisms that are disease-causing and can be added to tap water to make it safer for consuming.



## 6.20 Activated charcoal in water treatment and purification

Activated charcoal can be used as a water filtering medium for the purification of drinking water. It is widely used for the removal of contaminants in water due to its high adsorption rate characterized by its large surface area and porous structure. Activated charcoal filters have varied surface features and pore size distribution, which play an important role in the adsorption of contaminants in water.



## 6.21 Bottled water dispensers

These are pumps that are fixed on top of the water bottle which upon pressing or activating a button, water is discharged. The advantage of these water dispensing pumps is that they are portable and reduce the risks of water contamination and loss.



## 6.22 Promotion of the handwashing culture and hygiene

Since the COVID-19 pandemic struck, the practice of handwashing has been instilled in us. Before a customer checks into a food processing area, food vending area, or an eatery, he or she is required to wash his or her hands. The promotion of a handwashing culture helps in fighting transmission of diseases such as COVID-19 while also improving food safety.



## 6.23 Complete hand washing kit

A complete handwashing kit made of solid plastic is available for efficiently cleaning hands and maintaining proper hand hygiene. The container has a place for soap and a perforated lid that can hold water. Light and practical, this kit is ideal for the home or workplace.



## 6.24 Soap dispensers

Wall-mounted soap dispensers are widely used in Senegal. With a single press, soap droplets are released, and the user can wash his or her hands with running water from the tap.



## 6.25 Foot pedal handwashing stations

Hands-free technology for operating faucets and dispensing soap has made handwashing easy with reduced touchpoints. By using a foot pedal, the user washes their hands without using them to open or close taps or pick up soap. This allows for a contactless hand washing system.



## 6.26 Alcohol-based hand sanitizers

The use of alcohol-based hand sanitizers has been key in the fight against COVID-19. While its increase in use resulted from the pandemic, it is also used to kill microorganisms that cause foodborne illness, without the need for soap or water.



## 6.27 Digitalized hygiene programs

In Dakar, customers can have their latrine pits emptied by sending an SMS message. A computer system then sends out a message to nearby waste collectors who can bid on the job and safely dispose of the waste. Senegal Sanitation Utility (ONAS) has welcomed and hailed the corroboration they have enjoyed with the private sector, namely Bill and Melinda Gates Foundation.



## 6.28 Wet wipes

Wet wipes are soft, gentle, nonwoven fabrics that contain a broad-spectrum antimicrobial that kills germs and disease-causing microorganisms. Wipes are enclosed in a re-sealable pouch which helps keep them moist. They can be used to clean hands and surfaces in the absence of soap and water.



## 6.29 Improved cleaning tools

Cleaning and sanitization are pillars for food safety and any kink within the process keeps food safety at risk. Cleaning tools help ensure a higher level of hygiene and sanitation and they make cleaning easy, safe, and fast.

### a) *Cleaning of cutting utensils*

Double-sided brushes affixed with a plastic handle are a cleaning tool that helps in washing sharp kitchenware.



### b) *Flexible spiral brush*

Some food processing equipment is curved making it difficult to wash. Flexible spiral brushes are a cleaning tool that can access parts that may otherwise be hard to clean.



## 6.30 Compressed towel tabs

These are fiber towels compressed into different shapes like tablets that expand when immersed in water. They are one-use disposable hygiene towels that can be used for cleaning hands or cookware.



# CHAPTER SEVEN - WASTE CONTROL AND RECYCLING

## 7.0 Introduction

Food waste must be collected, wrapped in impervious materials, and put in bins to prevent microorganisms and rodent infestation. Recycling waste is easier if it is separated at the point of source.

## 7.1 Fish waste treatment

Over 60% of the Senegalese population relies on fish to supplement their protein requirement. This makes fishing the second-largest economic activity after agriculture. This high consumption of fish has resulted in loads of fish waste and air pollution around lakes, rivers, and the Atlantic Ocean. Concerned citizens and the scientific community around the coastal region have been disturbed by the issue and have come up with different ways to reduce fish waste. The use of fish scales to develop biomass is a source of biofuel used to cook in the homestead. Offal obtained from fish industrial waste is used in making animal feeds (FAO,2019).



## 7.2 Waste segregation and disposal

Disposal of food waste has been an ongoing challenge for retailers in the food industry. Without a good system in place for disposal, food waste sits in ambient conditions which creates an environment in which microorganisms and rodents thrive. The development of plastic foot-operated bins has aided in the collection and disposal of food waste.



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