

REPORT

The Future Of Waste

Responsible Innovation in Food Waste

July 2018 - A report by

soScience
DRIVING RESPONSIBLE INNOVATION

What is actually in this report?

This report presents an overview of the theme, *i.e.* food waste challenges and solutions along the whole food chain, with a focus on fruit and vegetable waste.

This report is structured in two parts: in-depth insights into the social and environmental challenges related to the theme of waste (framed around the SDGs) and emerging solutions (from innovators and laboratories) to these challenges. The solutions presented in the second part allow readers to discover what is at the forefront of research, innovation and technology today. Innovations mentioned can also tap into traditional knowledge and small emerging social companies. Each solution has its advantages and drawbacks, but it is not SoScience's role to decide which solutions are the best. It takes society as a whole to decide what the appropriate choices are, in an open, non-partisan and ethical framework.





Challenge #1

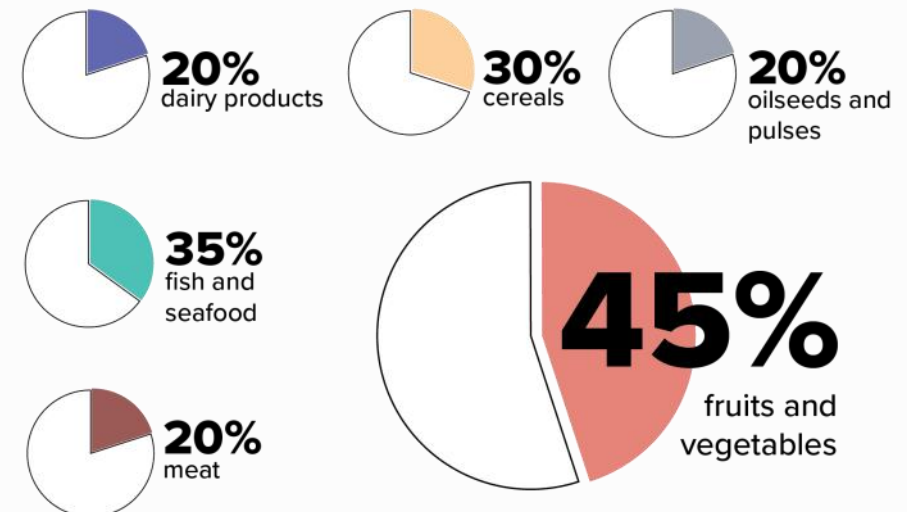
REDUCE FOOD LOSSES AND WASTE TO ENSURE FOOD SECURITY FOR ALL





As demography is rising, increasing by one third by 2050, from 7.3 billion today to 9.7 billion people, the common belief is that there might not be enough food to feed everyone by 2050, hence the imperative to increase food production.

According to the FAO, based on current trends, global agricultural production need to increase by 70% and double in developing countries to meet the growing food demand by mid-century. However, it is **not so much the population growth that is problematic but the failures of the current worldwide food system**: global agriculture is currently producing way more food than the world population needs. But **nearly one third of the food produced for human consumption (1.3 billion tons/year) is lost or wasted!** Just one fourth of the food currently lost or wasted could feed the 870 million people suffering from undernourishment.





TARGET 1-1	TARGET 12-3
ERADICATE EXTREME POVERTY	HALVE GLOBAL PER CAPITA FOOD WASTE
TARGET 2-4	TARGET 5-A
SUSTAINABLE FOOD PRODUCTION AND RESILIENT AGRICULTURAL PRACTICES	EQUAL RIGHTS TO ECONOMIC RESOURCES, PROPERTY OWNERSHIP AND FINANCIAL SERVICES

Food is thus not lacking but needs to be better managed in order to ensure food security. We need to find solutions that are not only adapted to the different steps in the food chain, but also to the local context where food loss and waste occur.

Improving food chain efficiency will ensure better food security, providing more food, and will **reduce poverty**, as food loss directly impacts small farmers economically and increases costs for poorer consumers. This is also an opportunity to innovate, as food waste streams and by-products are traditionally used for low-value animal feed or compost, to **upcycle these available materials into high-value added ingredients**.





Challenge #2

PROVIDE GOOD NUTRITION FOR ALL TO ENSURE HEALTHY LIVES





Beyond calories, **food waste is also contributing to nutrient loss while a growing number of people are suffering from malnutrition throughout the world**, both in developed and developing countries. As the demand for nutritious and healthy food keeps growing, the food industry must play a significant role in providing healthier options, making sure that nutritious choices are available and affordable to all consumers.

INNOVATE WITH THE NUTRITIVE POTENTIAL OF FOOD PROCESSING BY-PRODUCTS

Recycling nutrients from food waste, in particular from fruit and vegetables, to be incorporated into processed foods in order to **replace unhealthy ingredients and to craft new functional products** is one promising way to provide good nutrition for all. Indeed, the non-edible parts of fruit and vegetables, such as peels, seeds, stems, leaves and stones often present similar or even higher contents of antioxidant and antimicrobial compounds than the final product.

Nutritive Cost of Food Waste

At the retail and consumer levels in the U.S.
for each person in the U.S., we daily waste:

Calories 1,217

Protein 33g

Fiber 5.9g

Vitamin D 1.7mcg

Calcium 286mg

Potassium 880mg

Source: Johns Hopkins Bloomberg school of
Public Health's Center for a Liveable Future
(Spiker, Neff, et al., 2017)



In that respect, **research has a critical role to play in bringing recognition of nutritious by-products in order to spur food innovation** that can also address health issues.

Scientists are also studying the **link between nutrition and health**, starting to investigate the **intestinal microbiota** to understand how the microorganisms living in our gut work, influence our immune system and prevent diseases. Nutrition, through dietary fibers and polyphenols intake, has a positive impact on our intestinal microbiota. Fruit and vegetable food processing by-products are therefore a **new potential source for crafting functional foods or nutraceuticals** to address health and nutrition issues related to intestinal dysbiosis.





Challenge #3

ADDRESS ENVIRONMENTAL ISSUES WITH FOOD WASTE





Food waste contributes significantly to the **depletion, deterioration and disturbance of natural ecosystems and biodiversity** but also, directly and indirectly, to **GHG emissions**. The environmental impact of food waste is felt at all stages of the food system, from the use of toxic substances for production to unsustainable waste management practices, contaminating the environment.

The economic cost of this food wastage is estimated to be around **US\$700 billion in environmental damage** that will have to be paid for by society and future generations, according to the Full-Cost Accounting (FCA) of the food wastage footprint conducted by the FAO.

TACKLE FOOD WASTE TO PRESERVE BIODIVERSITY

Food waste has also a significant impact on wildlife. While animals have fed on human leftovers throughout history, the current high level of

In France, annual food waste carbon footprint reaches the equivalent of **15.15 million tons of CO2**.

Source: ADEME, *Pertes et gaspillages alimentaires : l'état des lieux et leur gestion par étapes de la chaîne alimentaire*, 2016.

The FAO estimates that food loss and waste is responsible for about 8% of global Green House Gas emissions, (3.3giga tons,) almost the equivalent of our global road transport emissions.



**The Carbon
Footprint
of Food
Waste**



TARGET 12•5



**SUBSTANTIALLY
REDUCE WASTE
GENERATION**

TARGET 15•5



**PROTECT BIODIVERSITY
AND NATURAL
HABITATS**

TARGET 13•1



**STRENGTHEN
RESILIENCE AND
ADAPTIVE CAPACITY
TO CLIMATE RELATED
DISASTERS**

TARGET 15•1



**CONSERVE AND
RESTORE TERRESTRIAL
AND FRESHWATER
ECOSYSTEMS**

food waste has altered the balance of the animal world. As a consequence, **food waste affects animal demographics, habitat location and behaviors** including reproduction patterns and predator-prey relationships.

TOWARDS A LOW CARBON ECONOMY

Industries are shifting to bio-based feedstocks to develop alternative sustainable raw materials to petroleum feedstocks. However, even though they secured sustainable and traceable supply chains, **land degradation, competitive use over food consumption and refurbishment time have to be considered to design a viable loop.**

In this regard, using food waste streams as new raw materials is a promising option, as it would reduce the use of raw materials from fossil-based carbon while preventing methane release from landfills.





Challenge #4

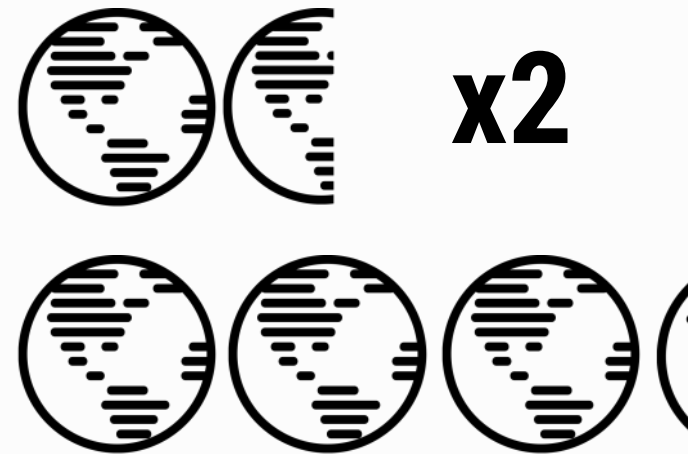
BUILD NEW MODELS TO PRESERVE NATURAL RESOURCES





We already consume the equivalent of 1.6 planets to provide the resources we use and waste. And yet, our consumption of natural resource is still increasing, driving by the consumer demands for all-natural products as it serves multiple purposes, including food, energy, medicine, beauty, and clothes.

One solution to the problem is to **keep resources within the economic system for longer by recovering food waste and by-products as new raw material**, as they do not require any extra farmland, water or energy, thus contributing to the preservation of natural resources.



Global resources consumption, equivalent of 1.6 planets, is expected to double by 2050 from 2015

Source: UNEP-International Resource Panel

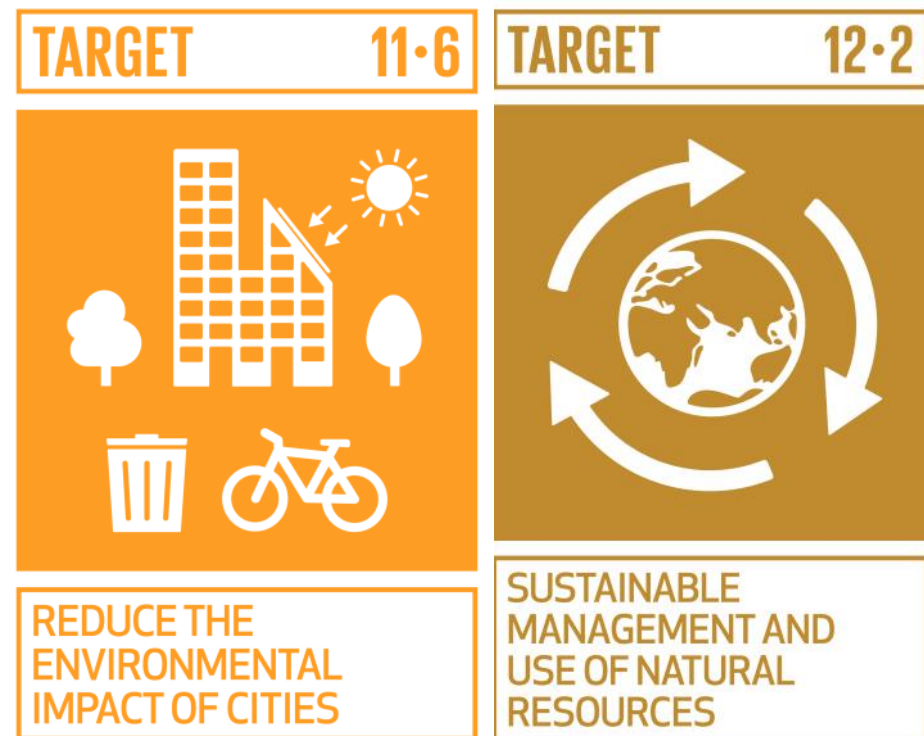


GOING CIRCULAR: USE WASTE AS A RESOURCE

Using waste as a resource, enabling companies to **reduce their reliance on virgin materials**. Redesigning the food chain on a circular model would reduce food loss and waste and re-integrate food into the productive cycle of the circular economy.

However, to embed circular principles into the food chain, stakeholders are facing **several challenges**:

- being able to **identify opportunities** along the value chain;
- unlock supply chain blockages through a **multi-stakeholder approach**;
- **improve knowledge** for food waste recovery; ensure economic viability;
- adopt a **systemic vision**, taking into account all aspects of a product's lifecycle from design to recovery;
- **going local**, to keep the beneficial effect of the circular model in terms of carbon footprint.







Challenge #5

LEAD RESEARCH AND BUILD NEW PARTNERSHIPS





FROM RESEARCH TO INDUSTRY

The research into food waste valorization has attracted a lot of attention over the past few years as a potential alternative to food waste disposal.

While there are very promising scientific results at the research stage, this **scientific knowledge needs to be translated into efficient and economically viable industrial processes to reach full scale production.**

Many **hurdles remain** to achieve practical and profitable processes and business models at the industry level such as:

- Technological and commercial immaturity
- High costs
- Limited availability
- Safety regulatory standards
- Consistency in final product
- Consumer acceptance

“The present state of research suggests that the thousands of studies performed on the utilization of by-products have led to a comparatively low number of established processes for valorization on an industrial scale”

Prof. Andreas Schieber, Institute of Nutritional and Food Sciences, University of Bonn

Quote from “Side Streams of Plant Food Processing As a Source of Valuable Compounds: Selected Examples” in *Review of Food Sciences and Technology*, Vol. 8, Issue 1, April 2017.



GOING CIRCULAR TOGETHER

Food waste concerns all stages along the food chain and therefore all lines of business. The food system is also embedded into complex global supply chains: production and consumption often take place in different countries, involving multiple companies around the world.

Reducing food waste therefore requires systemic change and for this reason, there is a need for collaboration between all stakeholders as it cannot be achieved by any single actor.

Partnerships can be lead to different goals, from being inspired, learning from best practices and sharing knowledge to promote synergies and strengthen means of action and mutual aid.





Solution #1

REDUCE FOOD WASTE ALONG THE VALUE CHAIN

To reduce food waste, a first, common sense solution would be to throw out uneaten food.

Among the **best-known initiatives** to reduce food waste are awareness ad campaigns, regularly deployed to raise consumer's awareness of food waste and national bans on throwing out unsold food in favor of donations. However, such initiatives leave the biggest problems unsolved: they **only alleviate food waste issue at the end of the food chain, but they don't solve the real issue of food waste upstream.**

Science and technology can contribute solutions all along the food chain to reduce food waste significantly, whether through

- **electronic sensors/low tech devices** to help reduce the significant amount of waste associated with food logistics and ensure that food stays fresher as long as possible.

- the use of **blockchain** and **artificial intelligence** to improve traceability and optimize storing ;
- the development of **smart packaging** thanks to **nanotechnologies** and **traditional knowledge**;
- or by making fruit and vegetable more resistant to spoilage with **biotechnologies**.



Tent filled with a sterilized gas that reduces the amount of ethylene, responsible for the ripening process of fruit and vegetables by social enterprise Wakati





Solution #2

UPCYCLE WASTE INTO HIGH-VALUE FOOD INGREDIENTS

Fruit and vegetable waste contains components and nutrients (dietary fibers, polyphenols, ect) with health benefits that can be extracted and valorized to **enhance the nutritional profile of existing processed food** and/or create **new functional foods**.

Social scipreneurs around the world are indeed creating new functional ingredients in order to substitute unhealthy ingredients in highly processed food products and provide a healthier composition.

Monterrey-based startup **Genius Foods** is turning mango seeds, peels and leftover pulp into a fiber-packed powder that acts as an emulsifier to replace up to 50% of the eggs and oil in baked goods.

Green Spot Technologies, a spin-off company of the University of Auckland, specializes in the valorization of fruit and vegetable by-products into high value-added food products using disruptive fermentation technology.

Major companies are also on board! In 2014, **PepsiCo** partnered with the **Clinton Foundation** and **Acceso Cashew Enterprise**, an Indian social enterprise, to create a new supply chain for the cashew fruit (containing as much as 5 times the vitamin C of an orange) to be incorporated into some of its blended juice products under the Tropicana label.

The American food company **Sir Kensington** developed a new ingredient to make an eggless mayonnaise, from a by-product of hummus manufacturing: aquafaba, the viscous water left over after draining chickpeas.







Solution #3

UPCYCLE WASTE INTO SUSTAINABLE RAW MATERIALS

Beyond the food industry, **food waste can be recycled for multiple applications, from textiles and fashion to packaging, cosmetics and building materials, opening up new economic opportunities for food processing industries.**

Food waste can provide:

- **fibers** for the fashion industry, bio-based packaging and building material.
- **lipids** contained into fruit waste can also be incorporated into cosmetic formulas to benefit from their properties while ensuring a sustainable sourcing of natural ingredients.
- **polyphenols**, with antioxydant properties, present in the seeds, stems and leaves of fruit and vegetable can be recycled as active ingredients for the beauty industry. Among them, anthocyanins can be also recycled as natural pigments for the food and the fashion industry.

Discover which start-ups and major players are pioneering these fields!



Affordable sanitary protections made from banana stem fibers by social enterprise Saathi





Solution #4

COLLABORATE WITH NEW PARTNERS



Recycling its own food waste streams is a good way for an industry to achieve a zero waste strategy and to reduce its negative impact. **Recycling another industry's waste stream**, however, has a **tremendous positive impact as it absorbs external waste while spurring innovation and opening new business opportunities.**

In the food industry, waste and by-products can have a large number of very different applications, giving industries the opportunity to collaborate across sectors and to innovate together.

Some major companies have already settled collaborative partnerships around food waste!

“One guy's trash can be another guy's treasure... working with an industry you never thought of working with before has been extremely valuable.”

Deborah Mielewski, Senior Technical Leader of Materials Sustainability at Ford Motor Company Research

As this circular model of food waste streams is only starting to take shape, **new players are emerging as facilitators to support and bridge all stakeholders involved in the food chain and other industries.** Large companies can also rely on social **entrepreneurs as explorers!**

Nowadays, consumers have become more and more socially conscious and are moving to ethical consumption: as a result, large scale companies can no longer limit themselves to charity actions or philanthropic collaborations. As visionaries and pathfinders, social entrepreneurs, with knowledge from the field, are strategic players to partner with.

Discover which key players are taking part to this kind of successful collaborations!



Get the full report!

- Acculturate your team and your partners to this strategic issue through a detailed state of the art
- Bring a new mindset to your existing projects and leverage new opportunities
- Gain a better understanding of new players (such as scientific social entrepreneurs) and new markets



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