Global Panel
on Agriculture
and Food Systems
for Nutrition

Preventing nutrient loss and waste across the food system:

Policy actions for high-quality diets

This policy brief shows that a reduction in food loss and waste, particularly in high-nutrient foods, has the potential to yield substantial nutritional benefits, contributing to the achievement of the Sustainable Development Goals. Addressing loss and waste of nutritious foods should be a specific new priority for improving nutrition.

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ABOUT THE GLOBAL PANEL ON AGRICULTURE AND FOOD SYSTEMS FOR NUTRITION

The Global Panel is an independent group of influential experts with a commitment to tackling global challenges in food and nutrition security. It works to ensure that agriculture and food systems support access to nutritious foods at every stage of life.

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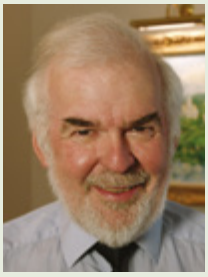

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Executive Summary

Loss and waste of nutritious foods needs to be an urgent 'new' priority for improving diets and nutrition. Both fundamentally affect the availability and affordability of foods which make up healthy diets, and represent a major food system dysfunction that can no longer be tolerated. Every year, approximately 1.3 billion metric tons of food produced for human consumption – one third of the total – never reaches the consumer's plate or bowl (see Section 2), yet 3 billion people today have poor or inadequate diets. The combined threats of micronutrient deficiencies, undernutrition and obesogenic diets pose a serious challenge to policymakers – not only in terms of the health, learning capacity and productivity of their citizens, but also in relation to mounting healthcare costs associated with poor diet quality.

Reducing loss and waste in nutritious foods would yield substantial benefits far beyond addressing hunger and malnutrition – to encompass economies and the natural environment. The gains made would contribute to the efficiencies needed to address climate change. Eating more of the nutrient-rich food already being produced would unlock savings in water and energy consumption, land use, and resources used in industrial food fortification. And the scale and pace of food production would not need to increase at the rates currently required to feed an extra 1 billion people by 2030.

> "The economic cost of malnutrition is too high for us to ignore the leakage of nutrients by food loss and waste in our food systems."
>
> **Akinwumi Adesina, Global Panel Member, and President of the African Development Bank**

However, addressing loss and waste in nutrient-rich foods presents a particular challenge. Foods such as fruits and vegetables, seeds and nuts, dairy products, meat, fish and seafood are highly perishable and often prone to pests and disease, making them disproportionately susceptible to both loss and waste. A key aim of this policy brief is therefore to provide advice to policymakers on how to proceed.

The brief analyzes the levels of loss and waste in nutritious foods in different regions of the world, and where those losses occur throughout food value chains. It also presents important new analysis which looks into the future to identify supply gaps that could develop in key nutrients unless action is taken. The same analysis is extended to quantify the benefits that could result if policymakers were to act to substantially reduce losses and waste.

The brief also examines the many ways in which food loss and waste occur across the food system – from agricultural production to processing and packaging, storage, transportation, retail, and through to people's own kitchens. Adopting a broad approach is critical because so much loss and waste occurs beyond the farm gate. Drawing on the latest evidence, the brief concludes by setting out six key priorities for action to reduce loss and waste of nutrient-rich foods. It also provides diverse examples of existing initiatives and potential innovations to guide action in both the public and private sectors.

Priority areas for action

① **Educating all food systems stakeholders to prioritize the reduction of food loss and waste.** Actions should include:[1] sharing information on specific loss reduction and waste prevention techniques; awareness campaigns at national, regional and global levels; labelling schemes; and updating Food-Based Dietary Guidelines to align recommendations with policies and programmes to tackle food loss and waste.

② **Taking practical steps for nutrient retention within the food system.** Policymakers need to develop a plan that focuses on perishable, nutritious foods and all parts of the food system, including consumer behaviour. The critical role of small and large businesses beyond the farm gate in managing losses and protecting nutrients should be emphasized given their importance in LMICs (see Tables 3 and 4). Public policies may be needed to incentivize changes in their behaviour.

③ **Improving public and private infrastructure for well-functioning and efficient food systems.** Efficient market, storage, cold chain and processing infrastructure can all play important roles in helping to avoid losses. Given that public funds for these actions may be limited, governments should consider promoting an enabling environment for the private sector by, for example, streamlining processing of planning applications and ensuring business-friendly legal and regulatory frameworks. The promotion of PPPs may also be valuable in realizing actions and investments. (Table 3 provides a list of policy actions, PPPs and non-profit organisation interventions; see also Hegnshol et al, 2018[15].)

④ **Encouraging innovative solutions to protect nutrients.** Innovative technologies have great potential to protect nutrients from farm to fork and tackle losses of perishable, nutritious foods in lower-income countries (see Table 4 for examples). Realizing this potential requires an enabling policy environment conducive to innovation, with multi-sectoral collaboration in the area of research and development, as well as cooperation in basic research.

Two further priorities are also important for researchers, scientists and donors, as well as policymakers:

⑤ **Closing the data gap: improving data collection and analysis.** A drive to share evidence more effectively and to strengthen capacity – using the appropriate data – is essential to supporting critical policy choices.[84] More precise estimates of losses and waste are now being made but the lack of data in low- and middle-income countries remains a major barrier.[16] Policymakers need to adopt a standardized approach for accurate assessment of the scale of losses at national and local levels.[xiv]

⑥ **Closing the knowledge gap on losses and waste.** This should: identify cost-effective interventions that can be scaled up; promote better understanding of losses in urban diets linked to processed and packaged foods; consider the role of public actors to embed technologies for reducing loss and waste (for example relating to better storage of nutrient-rich perishable foods used in public institutions); and evaluate the impact of post-harvest losses on livelihood and nutrition outcomes.

1. Introduction

The traditional policy response to ensuring food security has been to promote higher output of staple crops, such as grains, tubers and other starchy foods, which provide the bulk of people's nutrient energy (kilocalories). This approach served the world well during the past half century, supporting remarkable gains both in agricultural productivity and stable commodity output. As a result, the world's total supply of calories has never been greater in human history.[2] Even countries unable to produce staple commodities have been able to access agricultural surpluses through international trade. Today, the percentage of people lacking access to the minimum caloric intake needed to maintain a productive life is 10.8% – down from 18.6% in 1990.[3] Also, the share of the world's population lacking in calories on a daily basis is currently 21%, and, under optimistic scenarios, is projected to fall to just 10% by 2028.[4]

However, policymakers around the world are increasingly acknowledging the challenge of meeting rising demand for a *healthy diet* rather than just calorie sufficiency. Even at very low levels of income, consumers demonstrate a desire to have a diet that offers more than merely starchy foods.[5] Dietary diversity, which can include meat, fish and dairy foods, as well as fruits, vegetables and legumes, is a human aspiration as soon as hunger gives way to choice.

Facilitating choice – enhancing consumers' knowledge and purchasing power, as well as enabling people to access a diverse range of foods – has become a growing policy priority as a wide range of diet-related diseases become more common.[7] Diet-related factors now account for six of the top nine contributors to the global burden of disease.[8] In other words, where malaria, tuberculosis or measles used to rank among the greatest threats to public health around the world, poor-quality diets have assumed their place.[8] Increases in non-communicable diseases (NCDs) associated with the rise of overweight and obesity, also linked to poor-quality diets, are a particular concern. Globally, in 2016 one in five deaths were associated with poor diets. Without urgent policy action, that ratio is likely to worsen rapidly in coming decades.[9]

Diets lacking in nutritious foods also impair child and adolescent growth and development.[10] This is because poor-quality diets are associated with widespread micronutrient deficiencies – a lack of key vitamins and minerals essential to healthy growth and productivity of all individuals.[11] These deficiencies carry significant risks for people's well-being, learning capacity and labour productivity, as well as mounting healthcare costs.[10, 12]

The key to addressing this growing crisis of diet quality is to take policy steps which enable people everywhere, of every age, to eat food containing the full range of nutrients needed to support their health and well-being. This means going further than implementing a new round of policies to increase and diversify food production. While this remains important, losing fewer of the nutrients already produced in the food system needs to be given greater priority.

The policy challenges associated with reducing food loss and waste to help meet the goal of healthy diets for all, occur across the entire food system. Nutrient-rich foods – notably fruits and vegetables, seeds and nuts, dairy products, meats, fish and seafood – are often costly to produce, prone to pests and diseases, and highly-perishable, making them disproportionately susceptible to both loss and waste. Many nutritious foods are also more water- and heat-sensitive than staple grains or tubers, making them particularly vulnerable to threats posed by climate change.[13] In other words, the very foods that are critical components of healthy diets are at the highest risk of loss and waste (see Box 1 for definitions of the terms used in this brief).

Every year, approximately 1.3 billion[14, 15] metric tons of food produced for human consumption never reaches a consumer's

Box 1. Definitions[6]

Food loss: refers to a decrease in quantity or quality (appearance, flavour, texture and nutritional value) of food intended for human consumption. These losses tend to occur 'upstream' in the food value chain, and are mainly caused by inefficiencies in agricultural production, harvesting, post-harvest handling, transportation and storage of crops. They also occur in the midstream segments of the value chain when bringing foods to markets, during food transformation, and through wholesale marketing. At any stage in the value chain, foods contaminated with pathogenic microorganisms such as E. coli or aflatoxins produced by toxigenic moulds, must be withdrawn or discarded to avert food safety hazards.

Food waste: refers to the discarding of food appropriate for human consumption downstream in the value chain, particularly at the retail and consumer levels. For example, excessive grading and sorting of fresh produce to ensure the aesthetic quality and appeal of fresh produce to consumers can lead to waste. Other causes include spoilage (actual or perceived) linked to inefficiencies in transportation, storage, refrigeration and packaging of food, over-buying of perishable foods, and consumer habits. Consumer waste in high-income countries is typically linked to purchasing and storage of large quantities of food at the household level, inefficient meal planning and preparation, and post-meal disposal of non-consumed portions. This is not the case in many low- and middle-income countries where relatively small quantities of perishable foods are stored in the household, owing largely to a culture of 'fresh consumption'.

Box 2: Metrics for loss and waste: navigating data inconsistencies

Metrics used to describe food loss and waste include quantities (kilos or metric tons) of nutrient-rich foods and specific nutrients which are not eventually consumed. Other measures include economic losses (e.g. resulting from the need to produce more food to replace losses), or seek to estimate the resources wasted in producing nutrient-rich foods which never reach consumers. There are also metrics relating to the nutrient cycle – for example due to 'wasted' feed and fertilizer for producing food commodities which are not consumed. This kind of waste is likely to grow in importance as rising incomes and urban patterns of shopping and food use come to dominate the globe.[19]

There is also the issue of food recovery and redistribution through food banks which show an increasing trend, particularly in urban centres in both developed and developing regions. Many wholesale markets are now engaged in donating excess produce to food banks for redistribution – although whether all of this food is actually consumed is a complex issue, linked to taste, preferences and culture.

Care is also needed in interpreting data relating to food loss and waste due to inconsistencies in the way that data are presented. For example, the quantity of resources used, the economic value, and the calories and nutrients of each food product will vary depending on the product lost or wasted.[20, 21] The use of dry mass and data aggregation to assess food loss and waste for different products typically fails to capture these differences.[22]

plate or bowl (see Section 2). Large quantities of nutritious foods are lost upstream and midstream in value chains, through deterioration and pest damage in storage, the use of milling and transformation, and inadequate cold chains.[16] Many nutrients are also lost through waste where retailers discard 'un-sellable' perishable products or consumers discard uneaten food (see Box 1).[17,18] These losses fundamentally affect the availability and affordability of nutritious foods, and represent a major food system dysfunction.

Addressing loss and waste of nutritious foods should be an urgent 'new' policy priority that can support other initiatives aimed at improving diets and nutrition.[23] This important goal will contribute to the Sustainable Development Goals (SDGs), particularly to SDG 2 which focuses on resolving hunger and malnutrition, as well as SDG 12 which specifically calls for a halving of food waste across the globe by 2030.[24]

Reducing post-production nutrient losses would also contribute positively to efficiencies needed to address climate change and to feed the growing world population. Eating more of the nutrient-rich food already being produced would result in savings to land, water and energy consumption tied to food production, and resources used in industrial food fortification. In addition, the scale and pace of food production would not need to increase at the rates currently required to meet the demand of an additional 1 billion people by 2030.[25]

A wide range of policy options are needed in low- and middle-income countries to reduce loss and waste of nutrient-rich foods and help ensure that high-quality diets are available, accessible and affordable. They include public and private sector investments and innovations in: efficient on-farm resource use, food processing and packaging, energy-efficient refrigeration, and market connectivity.

This brief sets out the magnitude of the problem across the food system, as well as the main drivers. It also presents analysis which quantifies the benefits that could result from efforts made to reduce loss and waste in terms of nutrition and health outcomes, and concludes with specific priorities for action.

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2. Food and nutrient losses across the food system

2.1 The quantity of food lost or wasted within food systems is significant

Despite problems with data on food loss and waste in terms of reliability and coverage (see Box 2), it is widely accepted that post-harvest losses and waste of food across the globe are both large and significant. According to the Food and Agriculture Organization of the United Nations (FAO),[14] roughly one third of the edible parts of food produced for human consumption globally never reach the consumer. At approximately 1.3 billion metric tons of food per year, this is equivalent to more than half of the world's annual cereal output (over 2.6 billion metric tons in 2017/2018).[26] In low-income countries, over 40% of food losses (by volume) are thought to occur in the post-harvest and processing parts of the food system, while in high-income countries[i], more than 40% of food waste occurs at retail and consumer levels.[14] Together they have a direct impact on the amount of food energy (calories) and vitamins and minerals that are actually available for consumption.

2.2 High-nutrient foods have especially high rates of leakage out of the food system

It is important to disaggregate data on losses and waste of nutrient-rich foods, given their central role in delivering healthy diets and their disproportionally high perishability. According to FAO,[14] for any given food commodity, *overall* loss and waste is fairly similar from high- to low-income countries although there are some exceptions. For example, in low-income countries there are particularly high levels of loss and waste in milk and dairy products (see Figure 4). There are also notably high levels of loss and waste of fish and seafood products in North America and Oceania (see Figure 3).

More generally, there are substantial differences between regions in terms of *where* in the food system loss and waste occur. Harvest and post-farm gate handling and processing losses are relatively high in low-income countries where infrastructure (handling facilities, energy for cooling, bulk packaging and transport) is limited and costly. In contrast, food waste in homes, restaurants and other food outlets generally tends to be much greater in high-income countries, and in urban areas in low- and middle-income countries – due, for example, to bulk purchases of perishable foods and to excessive portion sizes that are uneaten and discarded.

Because both the drivers and the magnitude of loss and/or waste can vary substantially through the food system in different locations (see Figure 9, Section 3), policymakers need to consider entry points for action which are tailored to individual circumstances. Figures 1-5 below highlight the percentages of loss and waste (by mass) of five categories of nutritious foods at different stages in the food value chain across seven regions.

i Whilst this brief is primarily concerned with food loss and waste in low- and middle-income countries, these issues are also considered in high-income countries where there are potentially valuable lessons which may be relevant to the former as they become wealthier.

2.2.1. Fruits and vegetables

Fruits and vegetables have the highest overall rates of loss and waste for any food products discussed in this brief. Figure 1 shows that across most regions, more than half of all fruits and vegetables produced are lost and wasted[27].

In low-income countries[ii], substantial losses of fruits and vegetables occur in agricultural production because of on-farm pests, plants and animal diseases, or pre-maturity harvesting (often due to drought) (see Figure 1[iii]).[17, 28, 29] Although inappropriate post-harvest handling, transport and storage are key drivers of these losses,[13, 17] the amount of fruits and vegetables lost during transformation and packaging, and wholesale and retail activities is even larger. This is mostly explained by the deterioration of perishable crops in warm and humid climates, often exacerbated by lack of infrastructure such as inappropriate storage facilities and poor roads. Seasonality of some crops (like mangoes or papaya) can also lead to unsaleable gluts.[30]

In medium- and high-income countries, on-farm losses also figure prominently, mostly due to pre- and post-harvest grading using quality standards set by retailers.[14] Losses incurred in transformation and packaging are relatively low in most high-income settings but waste at the end of the food value chain is more significant with 15-30% of purchases (by mass) discarded by consumers.[14]

2.2.2. Meat and meat products

Of the 263 million metric tons of meat produced globally each year, over 20% is lost or wasted[27] (see Figure 2). This is equivalent to the loss of approximately 75 million cows at the point of slaughter.[27] Overall losses are relatively similar in different parts of the world, although somewhat higher in sub-Saharan Africa.[27]

In low-income regions, losses are generally distributed evenly throughout the food system, but notable are the relatively high losses in production of meat and meat products in sub-Saharan Africa. About half of the total losses in this region occur here. According to FAO, this can be explained by high levels of animal mortality caused by diseases (e.g. pneumonia, digestive diseases and parasites).[14] In high-income regions, wastage of meat and meat products is most significant at the retail and consumer levels, arising from a high per capita consumption of these foods, combined with a relatively high proportion of wastage by both retailers and consumers.[31] Consumer waste makes up almost half of total meat losses and waste in Europe and North America.[14]

2.2.3. Fish and seafood

Globally, over 30% of the total fish and seafood harvested each year is lost or wasted.[27] In some high-income countries, much of this occurs at the consumer level, while in low-income countries substantial losses occur in the distribution/retail sectors (see Figure 3).

In low-income countries, losses in primary production are largely attributable to discard rates of between 6% and 8% of marine catches (see Figure 3). High losses in the distribution part of the value chain are due primarily to rapid deterioration of fresh fish and seafood in environments where suitable transport and cold chain infrastructure are lacking.[32] In medium- and high-income countries, losses in primary fish and seafood production are significant because of discard rates of between 9% and 15%.[33, 34]

2.2.4. Milk and dairy

In low-income countries, on average, loss of milk and dairy products during post-harvest handling and storage, as well as during distribution and retail, is relatively high at 7% and 9%, respectively. Access to cooling is a particular factor at play here. In sub-Saharan Africa, losses during post-harvest handling and storage was the highest at almost 11% (see Figure 4).

Losses in production are also significant in medium- and high-income countries since disease in dairy cows (mostly mastitis infections)[14] causes approximately 3% to 4% decrease in milk yield. However, in marked contrast to low-income countries, waste at the consumption level makes up the largest proportion of total loss and waste.

2.2.5. Oilseeds and pulses, including nuts[iv]

A range of oilseed and pulse crops are grown across the regions shown in Figure 5. For example, groundnut is a dominant oil-seed crop in sub-Saharan Africa; soybean and olives in North America, West and Central Asia; soybean and coconut in South and Southeast Asia, and soybean in Latin America.

In low-income countries, between 6% and 15% is lost during the production stage, and up to a further 11% is lost during post-harvest handling and storage. For example, cowpea in sub-Saharan Africa does not store well and nutrient content is reduced by pests. Loss and waste of oil crops during distribution and at consumption are relatively low as they are mainly in the form of vegetable oils which have low wastage compared to fresh products.[14]

ii In this brief we adopt the same classification of low- middle- and high-income countries as described in Annex 1 of the FAO report 'Global food losses and food waste – Extent, causes and prevention' (Gustavsson 2011). For example, low-income countries include those from the following regions: sub-Saharan Africa; North Africa, West and Central Asia; South and Southeast Asia; and Latin America.

iii The points made in sub-Section 2.2.1 are drawn from the FAO report 'Global food losses and food waste – Extent, causes and prevention' (Gustavsson 2011). Figures 1-5 are also from this report (based on 2007 production volumes for the commodity groups). However, it should be noted that the income groups referred to in the text (i.e. low- middle- and high-) do not always map precisely onto the regions used in the figures.

iv This group includes soybeans, groundnuts (shelled), sunflower seeds, rape and mustard seed, cottonseed, coconuts (incl. copra), sesame seed, palm kernels, olives, other oil crops.

Figure 1. Food loss and waste at different stages in the value chain: Fruits and vegetables

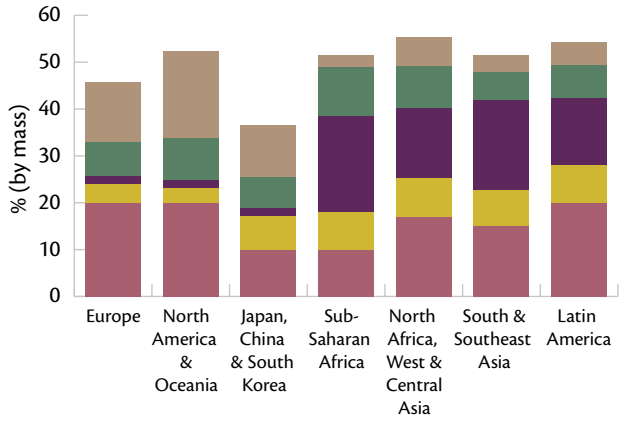


Figure 2. Food loss and waste at different stages in the value chain: Meat and meat products

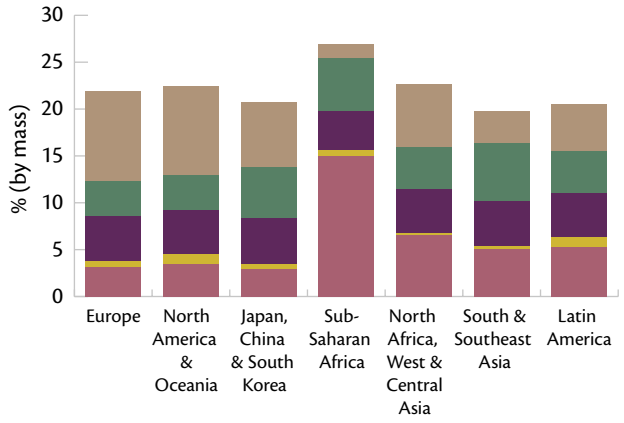


Figure 3. Food loss and waste at different stages in the value chain: Fish and seafood

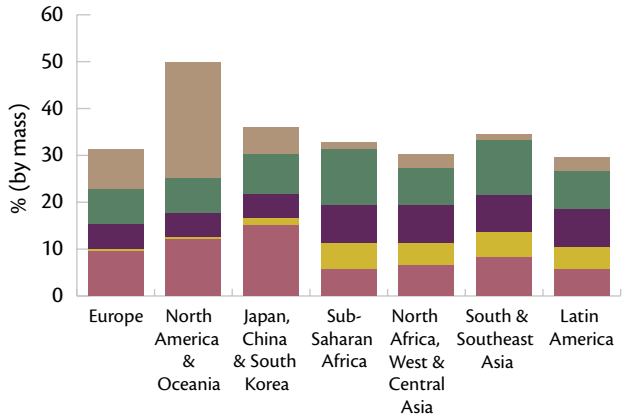


Figure 4. Food loss and waste at different stages in the value chain: Milk and dairy

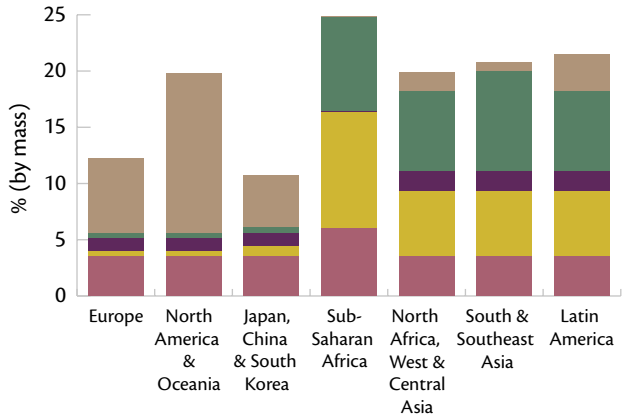
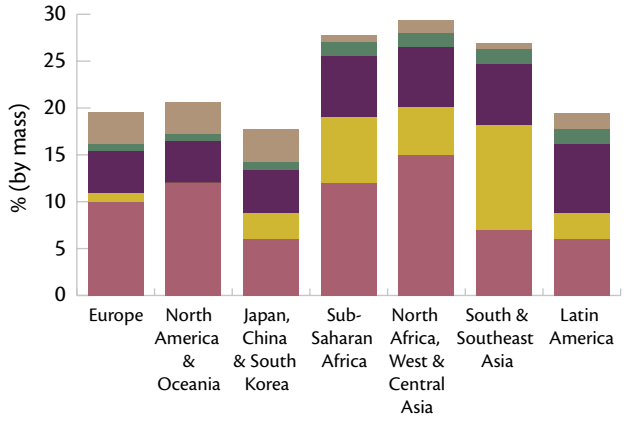


Figure 5. Food loss and waste at different stages in the value chain: Oilseeds and pulses



Key to figures 1 – 5

- Consumer level waste
- Distribution/retail level
- Transformation and packaging
- Post-harvest handling/storage
- Agricultural production

Source to figures 1 – 5:
FAO report 'Global food losses and food waste – Extent, causes and prevention' (2011)

2.3 Could the reduction of nutrient loss and waste help mitigate micronutrient deficiencies?

Nutrient loss and waste across the global food system represent missed opportunities to reduce malnutrition. This 'non-consumption' – i.e. not eating foods already being produced – can also be viewed in terms of the individual nutrients that are unavailable or lost to consumers. Policymakers should consider targeting losses of specific micronutrients alongside the need to reduce loss and waste of nutrient-rich foods. The World Food Programme's *Fill the Nutrient Gap* initiative, for example, analyzes nutrient gaps and barriers to adequate nutrient intake in specific national and sub-national contexts.[35]

A recent study[36] presents estimates of the global flow (including losses) of vitamin A, iron and zinc through the human food chain.[v] In the absence of fortification and supplements, the average global amount of vitamin A produced in human-edible crops was found to be nearly 22% greater than that required to meet the totality of human needs.[37] However, after loss and waste, the amount available for consumption was 11% less than that required. For iron, human-edible crops contain nearly seven times the amount needed for global human consumption, but just over twice the human requirement is actually available following losses, waste, and consumption by livestock destined for meat production. Zinc is better conserved throughout the food value chain. The total amount of zinc consumed is about 66% greater than human needs.

However, these global averages mask considerable local variation in terms of the nutrients actually available and consumed by individuals. Some of the most important deficiencies are associated with calcium, iron, vitamin A and zinc.[38] Deficiencies in a single micronutrient can carry serious health, as well as economic costs. For example, the cumulative economic cost of cognitive impairment and lower labour productivity due to iron-deficiency anaemia is on average 4% of GDP for low-income countries.[39]

While it is beyond the scope of this brief to review where and how losses occur for micronutrients in different areas of the world, the following sections present some examples of specific food system losses in vitamins A and C, iron and zinc.

v This study uses 2013 data.

2.3.1 A case study of vitamin loss and waste in fruits and vegetables

A global study[40] in 2009 on loss and waste of vitamins A and C in fruit and vegetable value chains in 7 regions,[vi] found that most vitamins which disappeared from the food value chain were lost on the farm, during post-harvest and at the point of consumption. In contrast, food processing accounted for the least loss and waste. High-income countries in Asia (Japan, China and South Korea) had the highest overall per capita loss and waste in vitamins A and C (vitamin A: 784 *µg* RE[vii, viii]/person/day and vitamin C: 90 mg/person/day); the lowest were found in sub-Saharan Africa (vitamin A: 135 *µg* RE /person/day; vitamin C: 26 mg/person/day).[ix]

For loss and waste in different parts of the food value chain, high-income countries in Asia, North America and Oceania had the highest per capita vitamins A and C loss and waste in agricultural production (vitamin A: 228 *µg* RE/person/day; vitamin C 33 mg/person/day). At the level of the consumer, waste of vitamins A and C in fruits and vegetables, was highest in Japan, China and South Korea, and lowest in sub-Saharan Africa.

2.3.2 A case study of total post-harvest micronutrient food losses and waste – iron, zinc and vitamin C

Another approach to quantifying micronutrient food losses and waste is to focus on value chains relating to specific food products. A recent FAO multi-country study estimated losses of iron, zinc and vitamin C in specific value chains, such as milk, rice and bananas in selected regions of Kenya, Cameroon and India.[41] It found considerable variation between different localities and different nutrients with loss and waste in vitamin C particularly high in the three countries, especially in India.

The study showed that addressing the nutrient losses by improved management of food value chains could theoretically reduce the prevalence of vitamin C deficiencies in children under 5 by up to 83% in Cameroon (see Table 1).

However, the potential improvements from eliminating losses in iron and zinc deficiencies in the chickpea, rice, milk and mango value chains in India were estimated at only 2%. This is mainly because the content of iron and zinc is relatively low in rice as compared to, for example, meat and meat products. It is reasonable to expect that if the losses of other food value chains were evaluated and losses addressed, the nutritional needs of potentially many more children under 5 years with micronutrient deficiencies could be met.

Table 1. Percentage of children under five years whose daily recommended amounts of selected micronutrients could be satisfied by addressing nutrient losses through specific food value chains in selected regions of Kenya, India and Cameroon

	Kenya	Cameroon	India
Iron	24%	15%	2%
Zinc	8%	12%	2%
Vitamin C	33%	83%	23%

Source: Paratore, et al (2018).

2.4. The economic burden of nutrient losses

According to global estimates compiled by FAO, approximately one third of all food produced in the world in 2009 was lost or wasted.[14] This total approximates to US$940 billion in worldwide economic losses per year.[42] As populations, incomes and levels of urbanization in low-income countries rise in the decades ahead, changes in dietary patterns could mean that the amount of food and nutrients lost could rise substantially.[43] In the USA, the average family of four wastes roughly US $1,500 worth of food annually,[44] while in the UK, the average household with children discards approximately £700 of food each year.[45] The potential increase in food waste and loss would be vast if low-income countries move broadly towards the levels of waste in medium- and high-income countries. However, cultural practices in these regions – where most edible parts of animals, plants and/or fish are consumed – may help to constrain such potential increases.

These figures underline the importance of addressing today's food loss and waste – and to prevent or limit any future increases. However, adopting economic targets for loss and waste reductions could result in quite different policy decisions compared with measures to reduce the mass of food loss and waste – as illustrated in the case example below. The implication is that choosing data and metrics on which to base policy decisions needs careful consideration.

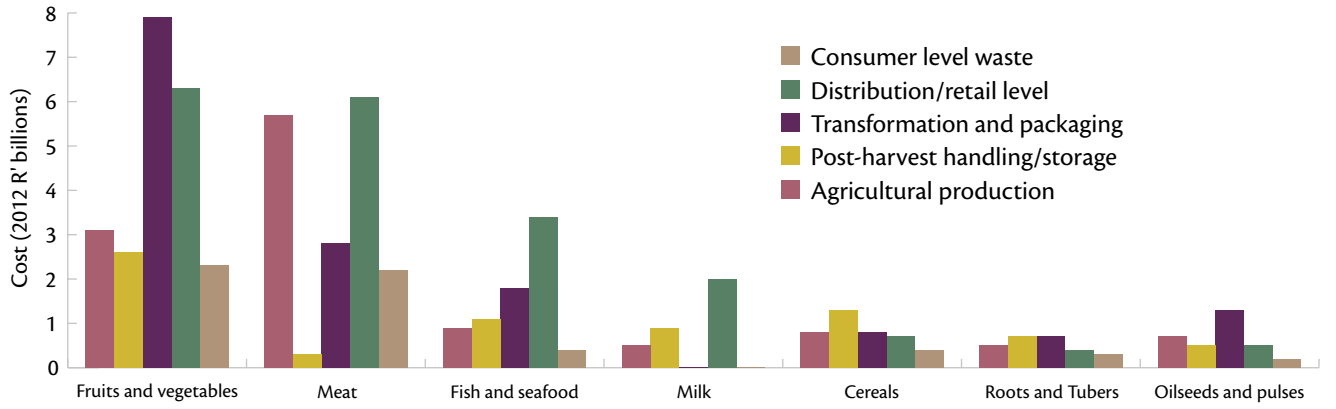
vi Europe; North America and Oceania; Industrialized Asia (Japan, China & South Korea); sub-Saharan Africa; North Africa, West & Central Asia; South & Southeast Asia; and Latin America.

vii See Serafini et al. (forthcoming) for a detailed description of how these figures for loss and waste were evaluated from these data sources.

viii 1 Retinal Equivalent (RE) = 1 µg retinol = 6 µg beta-carotene = 12 mg alpha-carotene. The Recommended Dietary Allowance (RDA) of vitamin C is 50mg for children 1-3 years and 75mg for women 19+ years. RDA for vitamin A are 300µg/person/day for children (1-3 years) and 700 µg RE/person/day for women 19+ years.

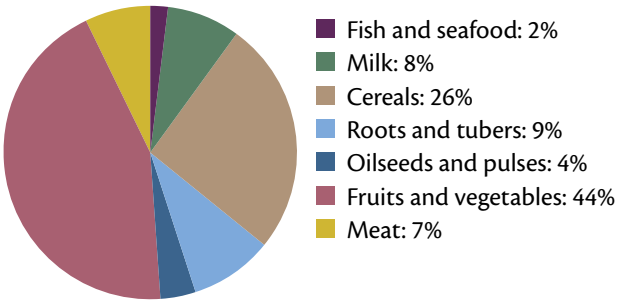
ix The reasons for this are unknown because the data are extrapolated from data on food loss and waste, and on the vitamin A and C content of fruits and vegetables. Data on vitamins relating to fruit and vegetable wasting for this region are available in the FAO report, but a scientific and practical assessment of that wasting was not made.

Figure 6. Cost of food loss and waste in South Africa at each stage of the value chain, by commodity group (2012 R' billions)



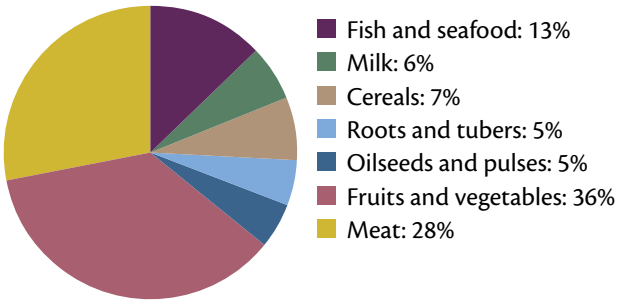
Source: Nahman & Lange (2013)

Figure 7. Relative contribution of food waste quantities in each commodity group to the total quantity of food waste in South Africa (%, by mass)



Source: Nahman & Lange (2013)

Figure 8. Relative contribution of the cost of food waste in each commodity group to the total cost of food waste in South Africa (%, by value)



Source: Nahman & Lange (2013)

Case example: the financial costs to South Africa[46]

The total cost of food loss and waste in South Africa already amounts to an annual R61.5 billion (approximately US $7.7 billion[x]). This is equivalent to 2.1% of South Africa's annual GDP (2012).[47] Figure 6 illustrates the exceptionally high total financial losses which occur in fruits and vegetables, and meat. Where in the food system these economic losses occur also differs markedly for different commodity groups (see Figure 6). The highest economic losses occur for cereals in post-harvest handling and storage; for fruits and vegetables in transformation and packaging; and for meat, fish and seafood and milk, at the distribution and retail level.

When targeting policy action to reduce the economic impact of food loss and waste, it is important to look closely at the available data. For example, from the South African study discussed above, while meat, fish and seafood together contribute only 9% by mass to total food loss and waste quantities (see Figure 7), the higher price of these commodities as compared to other food groups implies that together they contribute 41% to the total cost of foods lost and discarded in South Africa (see Figure 8). In this instance, measures to address waste at the food retailer and consumer levels would therefore need to give high priority to meat, fish and seafood if financial savings were targeted, but other commodities might need to be prioritized if the quantity of food loss and waste was targeted.

When these data are considered for different parts of the food value chain, the distribution, retail and consumption stages together contribute only 25% to total food waste by mass, but the higher prices associated with these later stages in the value chain imply that these two stages contribute 42% of the total cost of food waste in South Africa. The key point is that the criteria for policy action in different parts of the food chain need to take account of not only the quantity, and nutritive value of food losses and waste, but also the economic impacts on consumers, businesses and other stakeholders.

x This calculation is based on estimates of the value of food waste at each stage of the value chain multiplied by representative prices for various food groups. See Nahman and Lange (2013).

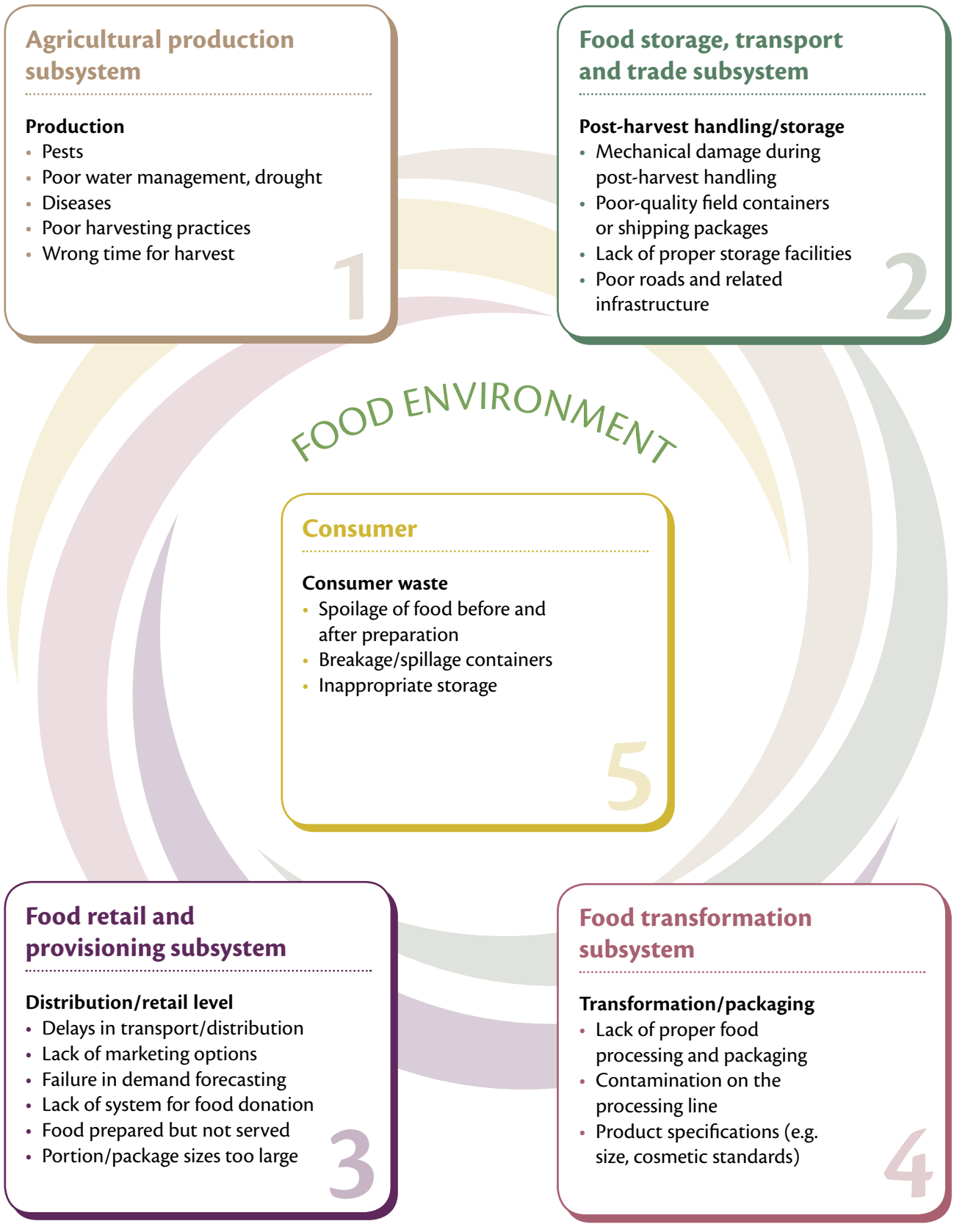
3. Drivers of nutrient loss and waste

It is essential to take a broad system-wide approach to reducing loss and waste – Section 2 showed that losses and waste of nutrients can be substantial at all stages in food value chains. Figure 9 shows that there are many drivers of losses and waste which can operate at all points – from production, through food transformation, storage, transport, retail, and the home. In addition, consumer perceptions, behaviour and practices may differ markedly between rural and urban environments, socio-economic status, and different religious and cultural norms. Some important factors – such as knowledge and skills of how best to preserve nutrients in food – may be cross cutting and relevant through different parts of food value chains.

Policies and actions to tackle food loss and waste also need to be matched to local circumstances. A study[48] in 93 low- and middle-income countries between 1990 to 2011 found that as much as 49% of food loss could be eliminated by improvements in agricultural machinery, transportation and telecommunications, enabled by increases in national income. Access to regular energy supplies, and the implementation of relevant government policies and enforcement of regulation, have also been recognized as key factors that influence food loss in lower-income settings.[48]

Minimizing factors which drive food losses and waste is all the more important given evidence[49] of a marked decline of nutrient levels in recent decades in a broad range of fruits and vegetables (and other agricultural products). Research shows that these reductions are due, in part, to selection processes in crop and animal breeding which have prioritized other food attributes (e.g. growth rates and aesthetic factors – see Box 3) rather than nutrient quality of the food produced. While these reductions do not necessarily constitute 'losses', they underline the importance of preserving the remaining nutritional qualities of foods as they pass from production to the consumer.

Figure 9. Examples of drivers of food loss and waste through food systems



Source: Authors, based on the World Resources Institute report 'Food Loss and Waste Accounting and Reporting Standard' (Table 11.2, p. 92).

Box 3. Causes of food loss and waste due to cosmetic attributes[49]

Sellable physical attributes

Food is discarded throughout the value chain because it fails to meet the aesthetic requirements of supermarkets. Food that does not meet the required standards is either sent for sale to secondary markets (at a substantially discounted price) or left in the field. Farmers that specifically engage in modern value chains commonly overproduce food to ensure that they can meet the expected volume of produce orders in line with these standards. The result is the loss and waste of food which is entirely fit for consumption, the misuse of natural resources in production and entrenched inefficiencies in the global food economy. Suppliers from high-income countries also claimed that cosmetic specifications are used by supermarkets and intermediary suppliers as a means of rejecting food, thereby shifting the risk and costs of fluctuating demand to others.

The situation is different, however, for farmers who still engage in traditional supply chains which feed mass markets. Here the cost of foods is likely to be more important, rather than their physical attributes. In Senegal, individuals involved in the mango value chain in 2016 argued that cosmetic specifications were too strict, preventing good quality, edible mangoes from being exported. An estimated 65% of mangoes in Senegal are lost or wasted every year (88,000 metric tons). Moreover, the large volume of fruit left to rot in the field increases the prevalence of fruit fly, leading to further losses.

The following three examples illustrate how different drivers of food losses and waste can be influential in different contexts. They underline the importance of tailoring policies and actions to local conditions.

Example 1: The views of producers in member states of the Organisation of Islamic Cooperation (OIC)[29]

Producers from 30 of the 57 OIC member states across the Asian, African and Arab regions were asked for their views on where and why the main losses of fruits and vegetables occurred at country level.[xi] The most important factor for production losses was poor information and planning: this sometimes led to a total loss when prices at harvest were so low that farmers left the crop unharvested. Poor harvesting practices which involved careless handling and rough treatment, were also influential. Lack of proper storage facilities, especially those without temperature control, led to high losses – very few of the countries surveyed had cold stores which were efficiently managed and accessible to farmers. Some drivers of food loss had a strong impact across all three regions (e.g. on-farm pests, poor harvesting practices) while others such as poor seed quality showed considerable variation.

Example 2: Post-harvest loss and quality deterioration in horticultural crops in Dire Dawa Region, Ethiopia[30]

Research in Dire Dawa, Ethiopia in 2011-2012 found that post-harvest losses of 20% to 40% in fruits and vegetables[50] could be attributed to pollution from local cement factories, poor storage facilities, lack of know-how, poor management and weak marketing processes. Farmers were sometimes forced to sell their products at very low prices at the earliest opportunity after harvest[51] because of the absence of proper storage and marketing facilities, and seasonal surpluses. The absence of a 'maturity index'[xii] was a frequent cause of high post-harvest loss and quality deterioration.[52] Between harvest and consumption, temperature control was the most important factor in maintaining product quality.[52]

Example 3: Assessment of farmer level post-harvest losses along the tomato value chain in three agro-ecological zones of Ghana[53]

An assessment of the determinants of post-harvest losses within the tomato value chain in Ghana considered the pre-harvest, harvest and post-harvest handling of tomatoes across 46 districts. In Greater Accra, 69% of produce ready for harvest was being destroyed by stray animals and 58% of the remaining produce was lost during grading and packing. Late arrival of buyers, poor handling of produce, destruction by containers and over-packing were also cited as major factors for quantitative losses. In particular, Ashanti, Brong Ahafo and Upper East regions recorded significant losses in almost all post-harvest operations which were largely attributable to poor handling.

xi The Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC) 2016 report provides data on post-harvest losses in OIC countries for fruits and vegetables, and the following commodity groups: cereals; root and tuber crops; oilseeds and pulses; meat and meat products; milk and dairy products; fish and seafood products.

xii The maturity index for a commodity is a measurement or measurements which can be used to determine whether a particular commodity is mature.

4. Quantifying the benefits of reducing loss and waste in nutrient-rich foods

A critical issue for policymakers to consider is the extent to which reducing loss and waste in high-nutrient foods can help in delivering healthy diets for all. A new study[xiii] addresses this question by modelling scenarios of more versus less loss and waste in relation to the total global supply of nutrients. This exercise used a modelling system of country-level food balance projections, estimates of food loss and waste by food group over time, and nutrient content of different foods by region.[54]

The analysis considered two scenarios. The first was a 'rising food loss and waste' scenario, in which total global food loss and waste was projected to increase by roughly one third (37%) from current levels – largely as a result of implied food demand creation linked to poverty reduction and rising urbanization. In effect, this may be viewed as a 'business as usual' scenario in which substantial steps were not taken to reduce loss and waste. This would see global losses and waste *rising* from an estimated minimum of 1.3 billion metric tons per year in 2010 to at least 1.8 billion by 2030 (equivalent to one quarter of total production and one third of total consumption). The second – a 'falling food loss and waste' scenario – considered the effect on nutrient availability if policymakers took decisive action to *reduce* food loss and waste by 50% – a level consistent with the target set by Sustainability Development Goal 12.3.

Rising food loss and waste scenario

The analysis showed that by 2030, significant nutrient 'disappearance' would be associated with rising global food losses and waste.[55] As a percentage of nutrients available for global consumption, about a quarter of calories and protein would no longer be available to consumers, along with 18% to 41% of vitamins and minerals (particularly vitamin A, folate, calcium, iron and zinc), depending on geographic region. Across all food groups, half of all food loss and waste in this model was associated with nutrient-rich foods such as fruits, vegetables, legumes and nuts. In addition, about a third was associated with staple crops (e.g. grains, roots), while a smaller volume of loss and waste (roughly 5% for each) occur in animal products and fish.

In this scenario, overall food losses (and total food loss and waste) by 2030 were seen to be highest in high-income countries – despite on-farm and distribution efficiencies and greater access to appropriate refrigeration and packaging at retail and consumer levels. Calcium was the only major nutrient seeing more loss and waste in low-income settings than in high-income countries.

The effect of the modelled disappearance of nutrients from the food supply had different potential effects for human well-being depending on thresholds set for daily recommended intakes. The rising loss and waste scenario led to supply gaps for some nutrients. For example, there would be insufficient folate and riboflavin (B2) globally and in lower-middle-income countries to meet consumption requirements for all consumers. This was also the case for folate and iron in high- and upper-middle-income countries, and for vitamin A, riboflavin, folate, calcium and polyunsaturated fatty acids (PUFAs) in low-income countries. Importantly, even the supply of calories would be deficient in low-income settings in this scenario.

Falling food loss and waste scenario

The second scenario shows that reducing food loss and waste has the potential to improve projected nutrient supplies significantly. Halving food loss and waste could reduce deficiencies substantially: in high- and upper-middle-income countries, the supply of dietary iron is projected to increase above recommended levels. Similarly, folate deficiencies could decrease four-fold (as a result of rising availability in the food system). In lower-middle-income countries, supply of folate would (if consumed) increase to a level that would take consumers above recommended values, and riboflavin deficiencies would be halved. In low-income countries, the supply of calories would be sufficient to notionally allow all consumers to increase their intake to levels above minimum recommended values (assuming universal and equal access to those calories). The supply of vitamin A, riboflavin, folate, calcium and PUFAs (crucial for the prevention of NCDs) would all increase by one third to one half of current (deficient) levels.

In this falling loss and waste scenario, *fruits and vegetables* contributed most to the increased supply of vitamin A (61%)

xiii A working paper produced by Dr Marco Springmann was commissioned specifically for this policy brief, available at www.glopan.org.

and folate (50%). *Staple crops* contributed most to the increased supply of PUFAs (78%) and calcium (52%), and to increased availability of iron and zinc (67%-83%).

Reduced loss and waste of fruits and vegetables, and the associated increased consumption of these foods, had the greatest positive impact on health via diet (roughly 1 million deaths averted globally every year), followed by increased consumption of fish, then nuts, seeds and legumes.

Overall, this scenario suggests that a reduction in food loss and waste in nutrient-rich foods has the potential to yield substantial nutritional benefits. However, it also shows that substantially reducing food loss and waste overall (by half in this case) might also have unintended consequences that would need to be thought through by policymakers. For example, excess calorie consumption increased and the intake of saturated fatty acids also rose in all regions above recommended levels. More work needs to be undertaken to fully elaborate the costs and potential benefits of actions to reduce food loss and waste, compared with actions aimed at increasing production of nutrient-rich foods – this is particularly important as some actions have the potential to yield very substantial 'value for money' benefits (see Box 4).

Box 4. The value for money in reducing household food waste – UK case example[42]

In 2007, the UK launched a nation-wide initiative to reduce household food waste. By 2012, it had achieved a 21% reduction in household food waste relative to 2007 levels, particularly through the "Love Food, Hate Waste" radio, TV and online media campaign. The return on investment was substantial; the ratio of purely financial benefits to financial costs attributable to the UK initiative overall was more than 250:1. In other words, *every £1 invested in efforts to catalyze household food waste reduction resulted in savings of £250.*

Although high-income countries, such as the UK, generate more food waste at the consumer level than do low- and middle-income countries, this example illustrates the considerable benefits of reducing household food waste. As incomes continues to rise in low- and middle-income countries, the benefit of minimizing consumer level waste will become increasingly important.

5. Policy recommendations

5.1 A new policy agenda protective of nutrients within the food system

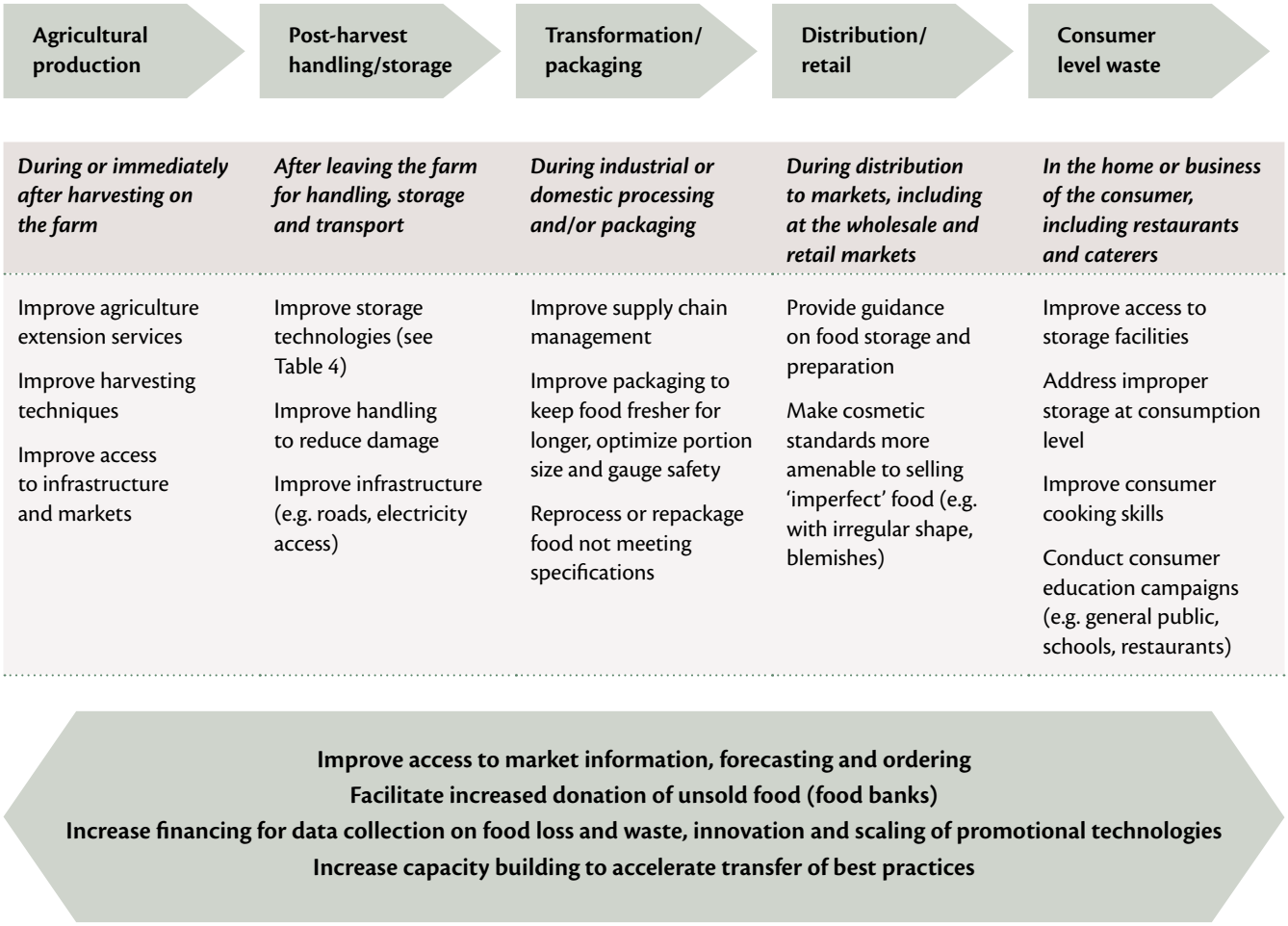
The international community needs to consider food loss and waste through a new lens: that of the nutrient quality of diets. This conclusion recognizes the central role accessible and affordable healthy diets will need to play in delivering SDG2, as well as many of the other SDGs – relating to health, education, human development, equality and economic prosperity.[10] Policymakers in low- and middle-income countries are increasingly recognizing the need to think differently about how to achieve healthy diets for all in an approach which goes beyond producing more staple foods.

The world requires increased production of all kinds of nutrient-rich foods – but equally important is tackling losses and waste of foods already produced as they move along food value chains. This will serve to increase availability without imposing further production-related costs on low- and middle-income countries, and on the environment. Rates of loss and waste are particularly high for high-nutrient, perishable foods – fruits, vegetables, animal source foods – and substantially increase the costs of nutritionally-optimal diets while reducing the essential nutrients available to consumers.

> “With the ongoing impacts of climate change, lack of sustainable cooling access and resource scarcity, the continued waste of nutrients is a huge dysfunction of the global food system that we cannot afford.”
>
> **Rachel Kyte, Global Panel Member and CEO of Sustainable Energy for All (SE4All)**

Foods that are nutrient-rich are susceptible to significant losses throughout the food system. There are inefficiencies and inappropriate practices on the farm, in storage and handling, during transportation, packaging, distribution, in processing and retail, and in the home (see Figure 9, Section 3 and Figure 10 below). Targeting reductions in rates of loss and waste and absolute levels of losses are both critical, especially for high-nutrient foods. In this way, through both direct and indirect measures (e.g. by investing in human resource capacity, technology and infrastructure), policymakers can drive food systems to become more nutrition-sensitive,

Figure 10. Approaches for reducing food loss and waste



Source: Hanson & Mitchell (2017), based on the Champions 12.3 report 'SDG target 12.3 on food loss and waste: 2016 progress report' (2016).

enabling healthier dietary patterns and improving nutrition without further challenging the use of scarce natural resources in agricultural production.

In the current era of rapidly rising levels of diet-related ill-health, the world must bring attention and resources to bear on making high-quality diets available to all. Nutrient-rich foods – such as those enhanced through biofortification, commercial micronutrient fortification of staples and processing – already receive significant attention from the private sector and deserve more consideration from policymakers. The prevention of the disappearance of nutrient-rich foods already in the food system has to be seen as a complement to the drive to increase food production.

Public and private actors also need to work closely together to build new partnerships to tackle nutrient losses and waste, particularly in perishable foods (see Table 3). Industry has hitherto led the way in reducing food waste – for example, by combining public responsibility and innovation in technology and packaging[56] (see Table 4), looking beyond production,[57] and particularly seeking to meet growing consumer demand for nutrient-rich foods.[58] By contrast, the public sector has focused more on losses in production. Both sides need to develop a common understanding of their respective roles in reducing food loss and waste in different parts of the food system, and their roles in scaling up cost-effective interventions. Farmers, food handlers, businesses, consumers and other food systems actors also need to be empowered with better knowledge of food and nutrition so that they can work together to reduce nutrient losses and waste in perishable foods. Overall, a new level of collaboration and ambition is needed – aiming for a much more integrated approach which combines their complementary strengths and leverage.

5.2 Actions needed to reduce losses and waste

Figure 10 illustrates many of the ways in which policymakers can target loss and waste in nutrient-rich foods throughout the food system. This mirrors Figure 9 earlier, which sets out the many drivers at play.

Table 3. Examples of policy actions, Public-Private Partnerships (PPPs) and non-profit interventions to reduce losses of nutrient-rich, perishable foods

Actions and interventions	Country examples
National policies/ programmes to reduce food loss and waste	In **Argentina**, the Ministerial Resolution 392/2015 created the *National Programme for Food Loss and Waste Reduction,* establishing the framework to strengthen the actions being carried out and to generate others in an integrated, coordinated multi-sectoral approach. The Government of **Brazil** has established several public policies with positive impacts in reducing food loss and waste. One example is the *Brazilian network of food banks,* which was created to strengthen and integrate the performance of food banks to help prevent/reduce food waste at both national and subnational levels. Additional food security policies and civil society actions on food loss and waste in the country can be found in the original source.[59]
Improved infrastructure	The *Market Infrastructure, Value Addition And Rural Finance (MIVARF)* project, led by the Government of **Tanzania**, is investing in roads, packing houses and food processing centres, post-harvest technologies and agro-processing, nutrient-preserving storage/processing, and refrigerated transport. In **China**, the *Development Plan for the Vegetables Industry* led by the National Development and Reform Commission and Ministry of Agriculture aims to reduce post-harvest losses of vegetables significantly in 2011–2020.
Adapted cold chain developments	The Government of **India** established the *National Centre for Cold Chain Development (NCCD)* in 2012 to promote and develop integrated cold chains in India for perishable agriculture and horticulture produce. In **Tunisia**, the development of the cold chain is part of the *National Food Security Strategy,* along with improving controls and harmonization of food safety and quality towards international standards. It is supported by a national plan for cold chains, with incentives for investment. The **Philippines** launched a *cold chain programme* in 2017. Similar programmes exist in **Egypt**.
Capacity building, education, training and extension services	*The Network of Excellence on post-harvest losses (NoE)*, a public-private cooperation project led by the **Netherlands**, was launched in 2015 to develop and apply knowledge on post-harvest issues for perishable food products in African, Asian and Latin American countries. The *Postharvest Education Foundation (PEF)* is a non-profit organisation training young people in lower-income countries on various aspects of post-harvest handling of perishable commodities including fruits, vegetables and root crops. FAO has also developed training manuals on Horticultural Chain Management, tailored to the **East and Southern Africa** context[60], and for countries in the **Asia-Pacific region**[61]. More than 1000 stakeholders from across the supply chain have been trained on quality management in fruit and vegetable supply chains.
Food banks	*ABACO*[62], a national network of food banks that serves the vulnerable, and the *Center for Latin-American Logistics Innovation (CLI),* have teamed up to reduce the wastage and improve the logistics of distributing surplus food to impoverished communities in **Colombia**. *Food for All Africa Programme*[63] – a food recovery organisation that operates West Africa's first food bank in **Ghana** – was established to rescue edible surplus food from stakeholders within the food value chain and supply to vulnerable beneficiaries.
Regional/ national awareness campaigns	*The Save Food Asia-Pacific campaign*[64] was launched in 2013 by the FAO Regional Office for **Asia and the Pacific**, in collaboration with the Asian Institute of Technology, to raise awareness and draw attention to the growing problem of food waste, especially of nutrient-rich foods, across Asia and the Pacific. *Save Food Campaign*[65] is an awareness raising and capacity development campaign to reduce post-harvest losses in horticultural chains in **Timor Leste**. In **Malaysia**, the *MYSave Food Campaign*[66] was launched in 2016 to promote awareness and actions to stem the problem of food waste among consumers across a broad cross-section of society, including ministries, organisations, households and schools.
Public/private coalitions	*Champions 12.3*[67] was created to bring together leaders from the public and private sectors in all parts of the world to promote the need to waste and lose less food.

Source: Authors, based on the HLPE report 'Food losses and waste in the context of sustainable food systems' (2014)[68].

Table 4. Innovative technologies to reduce losses of nutrient-rich foods

Technologies	Examples
Cold chain	***Small-scale chilling technology to reduce milk spoilage.*** Promethean Power Systems[69] has created an accessible chilling technology which has thermal battery backup, allowing it to operate reliably in rural areas of India where electricity supply is intermittent. ***Temporary cool chamber storage units for vegetables.***[70] Zero Energy Cool Chamber (ZECC) has tested cool chamber storage units of 100kg of mixed foods in various locations in India. Results from field trials demonstrated that weight losses were reduced by 20% and vegetable shelf-life increased from one day to between five and six days. ***Walk-in solar-powered cold storage for markets and farms.*** ColdHubs[71] was created as a 'plug and play' modular, solar-powered walk-in cold room for 24/7 off-grid storage and preservation of perishable foods in low- and middle-income countries (e.g. Nigeria). It is designed for installation in major food production and consumption centres, such as markets and farms. ***Refrigerated box for scooter transport.*** ColdEx[72] has created a battery powered cold chain storage box that sits comfortably on the back of a scooter. It makes temperature controlled transport accessible in congested urban areas for small retailers in India.
Processing/ Packaging	**PROCESSING** ***Multi-flash drying process for producing dehydrated fruits.***[73] An innovative drying technology has been developed in Brazil to obtain high-quality dried fruits and vegetables, reducing processing time and operational costs. ***Solar dryer technologies for drying of fruits, vegetables, spices and fish.***[74] Solar dryers are cheap, easy to build, do not require electricity or fuel and produce zero greenhouse gas emissions. They have been used in countries such as Bangladesh, India and Rwanda. ***Processing cashew apple juice.*** Working with a Brazilian juice distributor and a cashew nut producer, Maia Global[75] established a mobile factory near local farms in Ghana, to enable quick processing of cashew apples into juice directly from the farms. **PACKAGING** ***Fresh milk container designed to minimize contamination and ease transport.*** Mazzi[76] is a milk transport bottle that helps to maximize the amount of milk that makes it to market successfully, resulting in less spoilage and spillage. This technology is available in Kenya with plans to expand into Uganda, Tanzania and other sub-Saharan countries. ***Nanotechnology – A Hexanal 'smart delivery' liner***[77] built with nano-particles derived from banana and coconut fibres that reduces fruit and vegetable losses has been used in India and Sri Lanka. ***Waxing to increase shelf life of fruits & vegetables/ tubers & roots.*** RTB Endure (for 'Roots, Tubers and Bananas')[78] is a project run by CGIAR and the International Potato Centre to increase the shelf life of fresh fruits and vegetables.
Information and communications technology (ICT)	***Data app supports smart decision-making for farmers.*** RML ('Reuter's Market Light') Farmer[79] provides market prices via a mobile app, allowing farmers from Mumbai (India) to make quick decisions about where to sell perishable produce, improving farm profitability by an estimated 12% and reducing losses through better distribution. ***Knowledge of the cold chain at its various stages.*** Super-CoolAsia[80] has developed a service that tracks the temperature of storage containers in real time and sends notifications if temperature thresholds are breached in Asia. ***Mobile app supports food donations.*** In select cities in the Indian states of Tamilnadu, Andhra Pradesh and Kerala, people with large quantities of party leftovers, as well as hotels and restaurants with surplus food, can use a mobile app to tell No Food Waste[81], a local organisation committed to zero food waste, that food is available for collection. The group picks up the food and redistributes it to homeless people, as well as to slums, orphanages and elderly people. Users can also use the app's map to highlight "hunger points" where there are people in need of food, for those who want to donate directly.
Linking retailers to producers	***Online platform matches remote producers with urban retail outlets.*** Agruppa[82], in Colombia, leverages mobile phone technology to empower small food vendors in low-income neighbourhoods by providing them with fruits and vegetables purchased directly from smallholder farmers at wholesale prices.

Source: Authors, based on data from the Forum for the Future Disrupting Food Logistics Innovations Cards (2017)[83].

Priority areas for action

In prioritizing all actions, careful attention must be paid to local circumstances. Deeper analysis of where inefficiencies and dysfunctions leading to loss or waste occur in the food system is essential. This needs to be complemented by an understanding of where nutrient deficiencies can best be addressed by reduction of losses/waste in specific foods. A careful choice of metrics will help to define priorities for action. For example, decision makers might choose to focus on loss and waste measured in terms of the quantity of high-nutrient foods as they move through the food value chain; on economic factors that affect the affordability of nutritious foods; or on losses of specific nutrients. Notwithstanding these caveats, the following recommendations identify areas where actions should be prioritized.

1. **Educating all food systems stakeholders to prioritize the reduction of food loss and waste.** Actions should include:[1] sharing information on specific loss reduction and waste prevention techniques; awareness campaigns at national, regional and global levels; labelling schemes; and updating Food-Based Dietary Guidelines to align recommendations with policies and programmes to tackle food loss and waste.

2. **Taking practical steps for nutrient retention within the food system.** Policymakers need to develop a plan that focuses on perishable, nutritious foods and all parts of the food system, including consumer behaviour. The critical role of small and large businesses beyond the farm gate in managing losses and protecting nutrients should be emphasized given their importance in LMICs (see Tables 3 and 4). Public policies may be needed to incentivize changes in their behaviour.

3. **Improving public and private infrastructure for well-functioning and efficient food systems.** Efficient market, storage, cold chain and processing infrastructure can all play important roles in helping to avoid losses. Given that public funds for these actions may be limited, governments should consider promoting an enabling environment for the private sector by, for example, streamlining processing of planning applications and ensuring business-friendly legal and regulatory frameworks. The promotion of PPPs may also be valuable in realizing actions and investments. (Table 3 provides a list of policy actions, PPPs and non-profit organisation interventions; see also Hegnshol et al, 2018[15].)

4. **Encouraging innovative solutions to protect nutrients.** Innovative technologies have great potential to protect nutrients from farm to fork and tackle losses of perishable, nutritious foods in lower-income countries (see Table 4 for examples). Realizing this potential requires an enabling policy environment conducive to innovation, with multi-sectoral collaboration in the area of research and development, as well as cooperation in basic research.

Two further priorities are also important for researchers, scientists and donors, as well as policymakers:

5. **Closing the data gap: improving data collection and analysis.** A drive to share evidence more effectively and to strengthen capacity – using the appropriate data – is essential to supporting critical policy choices.[84] More precise estimates of losses and waste are now being made but the lack of data in low- and middle-income countries remains a major barrier.[16] Policymakers need to adopt a standardized approach for accurate assessment of the scale of losses at national and local levels.[xiv]

6. **Closing the knowledge gap on losses and waste.** This should: identify cost-effective interventions that can be scaled up; promote better understanding of losses in urban diets linked to processed and packaged foods; consider the role of public actors to embed technologies for reducing loss and waste (for example relating to better storage of nutrient-rich perishable foods used in public institutions); and evaluate the impact of post-harvest losses on livelihood and nutrition outcomes.

xiv For example: 'The Food Loss and Waste Accounting and Reporting Standard (or FLW Standard)[85] is a global standard developed by the World Resources Institute (WRI) which provides requirements and guidance for quantifying and reporting on the weight of food and/or associated inedible parts removed from the food value chain. It enables the consistent quantification of baselines and tracking of progress toward Target 12.3 of the UN Sustainable Development Goals, as well as other targets.[24]

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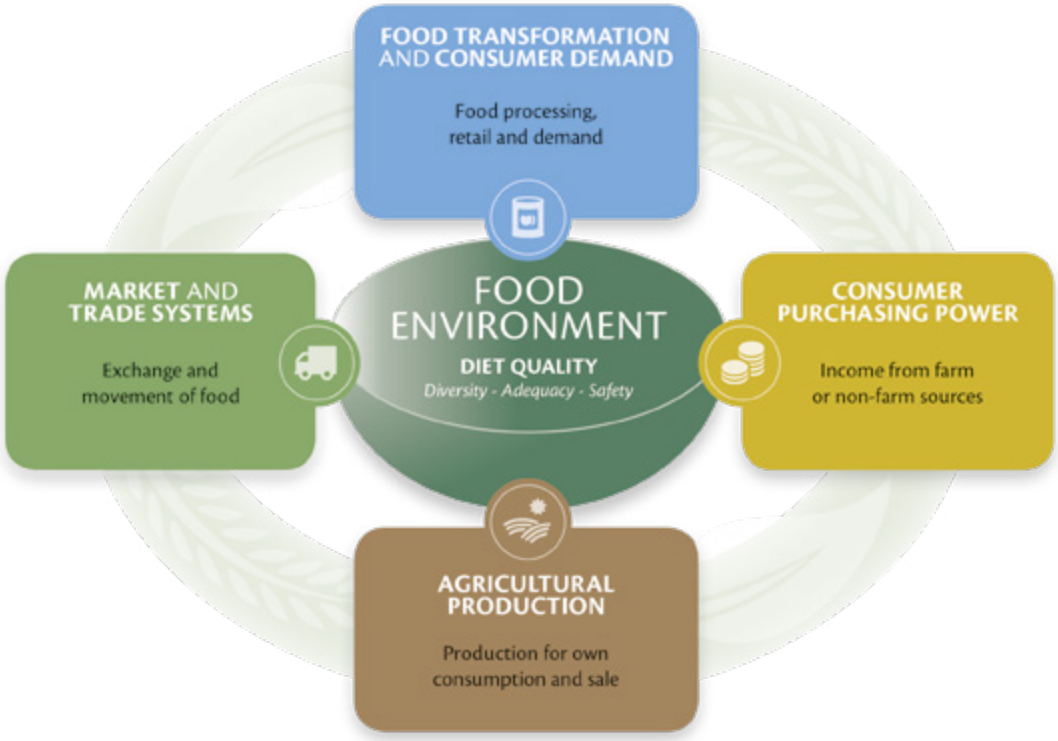
How can Agriculture and Food System Policies Improve Nutrition?

The multiple burdens on health in low – and middle-income countries due to food-related nutrition problems include not only persistent undernutrition and stunting but also widespread vitamin and mineral deficiencies and a growing prevalence of overweight, obesity and non-communicable diseases. These different forms of malnutrition limit people's opportunity to live healthy and productive lives, and impede the growth of economies and communities.

The food environment from which consumers should be able to create healthy diets is influenced by four domains of economic activity:



In each of these domains, there is a range of policies that can have enormous influence on nutritional outcomes. In the Global Panel's first Technical Brief, we explain how these policies can influence nutrition, both positively and negatively. We make an argument for an integrated approach, drawing on policies from across these domains, and the need for more empirical evidence to identify successful approaches.

Find out more here: Glopan.org/nutrition

Preventing nutrient loss and waste across the food system: Policy actions for high-quality diets provides key policy options within all of the domains of the food system to help governments address all forms of malnutrition.

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