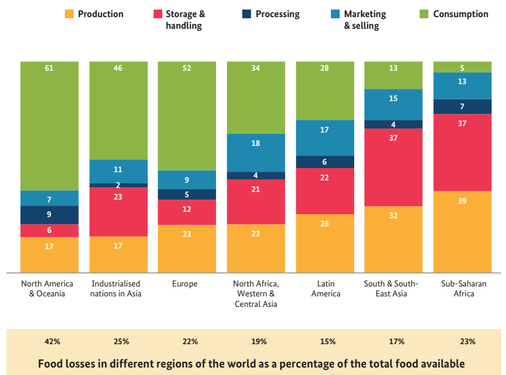

Food losses in different regions of the world as a percentage of the total food available

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Food losses

For sustainable resource use from field to fork

bmz.de

DEAR READER,

The Food & Agriculture Organization (FAO) estimates that around 30 per cent of all food is lost or wasted after harvesting. This translates into inefficient use of limited natural resources such as water, land and biodiversity.

For some years now the issue of rural development has been back on the political agenda. Amongst other reasons this is also due to riots in North Africa, the Middle East and Central America that were initially triggered in part by sharp rises in food prices. In addition, people living in the Sahel and the Horn of Africa still face the threat of famine. Throughout the world, the scarce natural resources needed for food production are under great pressure as a result of population growth, the rising demand for animal products that accompanies increasing affluence, competition from the use of biomass for energy, and the impacts of climate change. Increasingly, therefore, policymakers are turning their attention to the issue of food losses.

It is important to ask how losses on this scale arise and why producers, processors and consumers allow it to happen. These questions have not yet been explored in depth, but some plausible explanations have been put forward. The decline in investment in rural areas over many years provides the structural basis for food loss. Furthermore, the low prices paid to producers in recent decades have given farmers no incentive to invest in storage capacity and other upgrades. Producer prices are now rising, presenting an opportunity for small-scale producers to find a renewed courage to invest.

A renewed attempt to reduce food losses must consider the entire value chain from the field to the consumer, exploring the losses and efficiency potentials. This means that not only the producers but also a wide range of stakeholders in the public and private sectors must be approached and conferred with. Communication and collaboration between development cooperation, businesses, NGOs and researchers is essential in order to address this complex issue effectively and contribute to global food security.

This folder explores the issue of food loss in more detail and presents current experiences, challenges and areas of action.

Drying and cooling can make perishable goods more durable. © GIZ / Markus Kirchgessner

Taking bananas to market, © GIZ/ Martin Godau

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Improved maize store, Ghana. © GIZ / Heike Ostermann

Tea factory in Rwanda; losses occur along various value chains. © GIZ / Dirk Gebhardt

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Food losses

Problems and solutions

Background

Food losses and food waste refer to food that is produced but not consumed.

Food losses can occur at any point in any given food value chain before the product reaches the consumer – i.e. during production, transport, storage, processing, packing, distribution or sale. The magnitude of food loss and its causes vary widely, between different regions and different food value chains. Losses may already occur during production, for example as a result of poor-quality seed, crop disease, bad weather or inadequate technology. During harvesting some of the crop may be damaged by the methods used or rejected because it does not meet the required standards or is uneconomic to collect. Pests and diseases can cause losses during transport and storage. At the processing stage losses may be the result of incorrect handling or unused by-products. Damaged packaging results in losses during distribution and sale.

Food waste, by contrast, refers to food that is discarded by merchants or consumers while it is still suitable for human consumption or even after it has become unsuitable for consumption. Food may be discarded because it is not of the desired quality, because food-use guidelines do not allow for it being used, because it is not used before it spoils or because it has reached its 'best before' date.

The Food and Agriculture Organization of the United Nations (FAO) estimates that around one-third of the food produced for human consumption, is lost or wasted globally between the field and the consumer's plate. Thus a total of 1.3 billion tonnes of food is lost annually. There are large regional differences. In industrialised countries, much of the problem is due to wastage of food at the level of consumption. Extreme cases are North America and Oceania, where 61 per cent of food is wasted (FAO, 2011). In developing countries the majority of losses occur during production and storage. For example, the value of cereal losses in sub-Saharan Africa is estimated to be US$ 4 billion annually – the amount lost would feed 48 million people (FAO, 2011). In this region the percentage losses are even higher for perishable products, amounting to up to 50 per cent for fruits and vegetables and around 20 per cent for fish and seafood (FAO, 2011). In developing countries the factors driving the large losses during harvesting, transport and processing include premature harvesting, poor storage facilities (e.g. inadequate cooling), insufficient processing capacity or lack of distribution infrastructure.

Losses may be both, a loss of quantity and a loss of the quality of food. An example of quantitative loss is deterioration as a result of pests and diseases or disposal because of contamination by harmful organisms. Qualitative losses reduce the monetary or nutritional value of the food product. In the case of rice, for example, the higher the percentage of broken rice, the lower the price a seller may get for it. Food that fails to meet certain quality standards may not be sold to international markets. Poor quality not only affects economic outcomes but may also pose risks to consumer health. If food is not properly produced, processed and stored, it may become contaminated, for example by aflatoxins. The mould *Aspergillus flavus*, which is most frequently found in maize and groundnuts but also affects other cereals, oil seeds and spices, produces this powerful

Left: Processing cashews, © GIZ / Ursula Meissner

Right: Drying rice in Bangladesh, © GIZ/ Martin Godau

toxin that causes liver cancer, reduces nutrient uptake and weakens the immune system. In children it leads to stunted growth and delayed development. It is estimated that some 4.5 billion people in developing countries unknowingly ingest aflatoxins with their food.

Overall, food losses and food waste cause considerable economic damage. They also have a harmful effect on the climate. As a result of rotting food and the energy used in food production, among other factors, uneaten food is responsible for annual greenhouse gas emissions of between 3,300 and 5,600 million tonnes globally. It contributes to growing pressure on land use and increased water consumption, which can cause existing conflicts over land and water to escalate. Every year some 198 million hectares of land are used to produce uneaten food – that is an area roughly equivalent to the size of Mexico (World Resources Institute – WRI, 2013).

It is undisputed by experts all over the world that reducing food losses is an essential aspect of improving food security in developing countries. It is unrealistic though to expect losses to be reduced to nil, because the measures needed to protect crops and products would be prohibitively expensive; a certain level of loss corresponding with market prices and infrastructure development must be accepted as inevitable. However, research institutes, donors and UN organisations still work on an appropriate definition of food loss, arguing for example over whether losses in animal feed production should be classed as losses of food suitable for human consumption. In addition, work on standardising a method of measuring food losses is still in progress.

Approaches to reduce food losses

There are many ways of protecting food from pest infestation and deterioration. Effective solutions must take account of regional differences and contribute to removal of the causes of food loss throughout the value chain. For example, crops can be protected against aflatoxin contamination by inoculating the soil with strains of *Aspergillus* that do not produce any toxins. These close relatives of the toxigenic *Aspergillus flavus* crowd it out and thus reduce aflatoxin contamination of the soil. Improved harvesting and transportation methods prevent mechanical damage to crops, which can provide an opening for harmful organisms. Durability can be increased by appropriate processing and packaging. Drying food well before storage reduces the incidence of disease, while better methods of storage keep crops safe and hence protect farmers' incomes. For example, the FAO has demonstrated how improved storage can reduce food losses by providing 45,000 small metal grain storage containers, which have significantly reduced the level of loss (WRI, 2013).

It is also important to raise awareness of the issue of food loss. This can be done through smallholder information campaigns or through multi-stakeholder initiatives that bring various private and public-sector stakeholders together to promote investment in reducing post-harvest losses in developing countries (HLPE Report, 2014).

In the light of the world's scarce resources, its growing population and the central goal to improve global food security, the problem of food losses has resurfaced and attracted the attention of international stakeholders in recent years. Institutions such as the World Resources Institute (WRI) and the FAO have collaborated with the private sector in setting up initiatives that aim to quantify food losses efficiently and in an internationally standardised manner in order to improve assessment of the causes and extent of losses worldwide. The aim is to develop context-sensitive strategies that consider not only the end product but the whole value chain.

To achieve sustainable results, steps must be taken to ensure that food losses are no longer economically worthwhile. Government bodies play a key part in system change through their regulatory activities, for example to limit the size of sales portions. Businesses in the food sector, especially influential industry leaders, can also bring about system change through voluntary self-regulation in areas such as the definition of quality standards or support for contract farming in developing countries.

Project 2:
GlobE: The Reload project

The 'GlobE – Securing the Global Food Supply' initiative aims to identify shortcomings in agricultural research in parts of Africa, promote the application of results in the countries concerned and support the creation of research and development infrastructure. The 'Reload Project – Reduction of Post Harvest Losses and Value Addition in East African Food Value Chains' forms part of the GlobE Initiative. It is financed by the German Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Cooperation and Development (BMZ). Reload aims to make more food available and improve value addition in the region.

The researchers identify the most important regional products in three countries and consider the entire value chain. Namely these value chains are meat and milk in Kenya, fruit and vegetables in Uganda and cereals and tubers in Ethiopia. The project also promotes collaboration with the local private sector and local research and development institutions in order to encourage implementation of the results and knowledge transfer. An important aspect of Reload's work is securing the active involvement of farmers and other local stakeholders in the project from the start and linking their economic interests directly with Reload's research activities in order to keep value addition as much as possible within the country. Capacity building through research cooperation is another key element of the activities.

By 2014, Reload had extended its research activities to all four partner countries: Ethiopia, Kenya, Uganda and Germany. Students on master's and doctoral programmes have conducted research in the field and their initial results have been presented at various scientific conferences. The final results are expected before the project comes to an end in 2016.

Food market in the Pamirs, © GIZ/ Inge Fabian

Project 1:
Kenya: Post-harvest losses of mangos

Cooperation between GIZ and the Kenyan fruit-processing company Kevian (K) Ltd. provided an opportunity to address the issues of low productivity and post-harvest losses on small-scale mango farms. The competitiveness of Kenyan mangos was severely affected by poor quality and unsuitable handling and storage. A GIZ study (GIZ, 2011) calculated that only one per cent of the harvested crop was being processed and exported. Mango producer groups were therefore set up which now provide training in plantation management and post-harvest handling of the fruit. Losses on the plantations immediately fell by 40 per cent and losses during transportation and marketing were reduced by a quarter. As a result of advice and marketing improvements, productivity increased significantly, while production and transport costs fell. The support provided to rural service providers and private-sector associations made farms more efficient and more competitive. For the mango value chain this means that, instead of being an importer of frozen mango concentrate for fruit juice production, Kenya is now a producer and exporter of mango juice, other processed products and high-quality mango fruits.

Fresh fruit and vegetables command the highest prices but are more perishable than processed produce . © GIZ/ Martin Godau

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Rice mill in Benin, © GIZ/ Ollivier Girard

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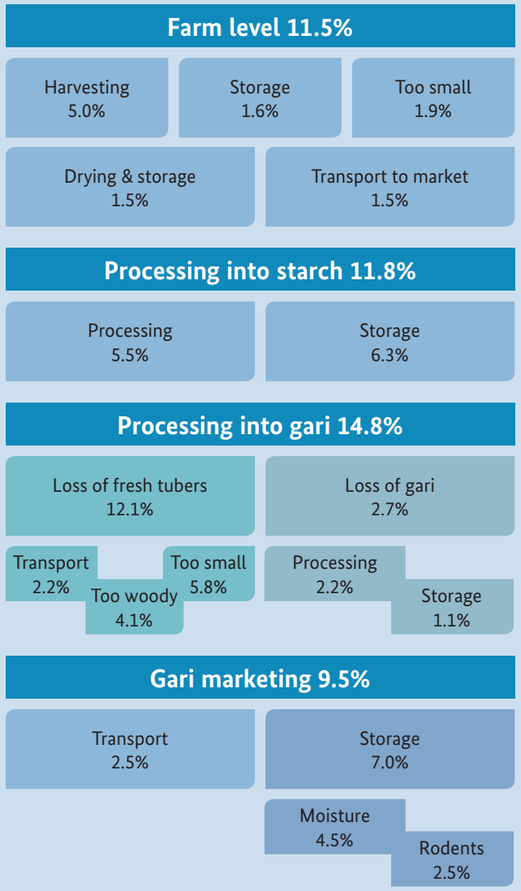
total 13.7 per cent. Most losses, though, occur at the marketing level (26.6%), mostly due to storage problems. Losses in the course of feed milling amount to 12.8 per cent. For the maize value chain, better packaging, transport and storage methods are therefore recommended.

The following measures are advisable to reduce post-harvest losses in the cassava and maize value chains: a) introducing standards for growing and processing, b) technology development through collaboration between public and private actors, c) strengthening farmers' organisations and cooperatives and d) developing small pre-processing centres close to farms to facilitate starch production.

Figure 3: Damage and loss along the cassava value chain in Nigeria



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Food losses and value chains

Examples from studies financed by BMZ

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has produced a number of studies that explore food losses in various value chains in more detail. The results increase the availability of data on food losses, and therefore contribute to the discourse on the methodology of food loss assessment and enable opportunities for the reduction of food losses in various value chains to be identified.

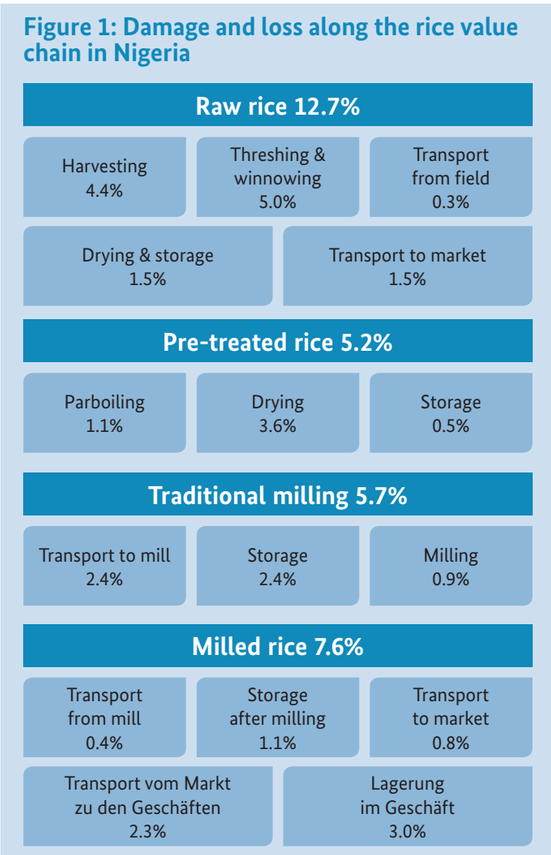
Study 1: Food losses and their ecological footprint in the rice value chain in Nigeria

More than 90 per cent of Nigerian rice is grown by smallholders: yields are low and most of the rice is processed in small local mills. In terms of both quantity and quality, production of raw rice and flour is significantly below the existing potential. Processors and consumers prefer to buy either rice from commercial producers or imported rice that is brought into the country to meet the rising demand.

Both traditional and industrial rice value chains in Nigeria were studied. The ecological footprint of the value chain was then calculated by performing a life-cycle analysis based on the indicators of greenhouse gas emissions, water consumption and land used for production.

Post-harvest losses in the rice value chains that were studied totalled on average 23.5 per cent of the yield. The resulting economic damage amounts to EUR 125.8 million. The value chains differ from

Figure 1: Damage and loss along the rice value chain in Nigeria



Rice threshing and rice processing.
© GIZ/Ollivier Girard

parboiling onwards (multi-stage rice treatment process). In the industrial value chain, threshed rice is purchased from smallholders and cooked, dried and milled in an integrated facility. By-products such as rice husks are used to heat the plant. Very little broken rice is produced in this system. In the traditional rice value chain, which is more widespread, additional qualitative and quantitative losses occur as a result of cooking, drying on the roadside and milling in small and inefficient mills. To reduce such losses, it is important to equip farmers with relevant knowledge, upgrade the technology used and improve storage. Measures such as microloans to facilitate investment, communal machinery use and the use of improved stoves that burn by-products as fuel should be promoted. There is a great need for extension services on the application of standardised methods of growing, storing and processing rice.

Analysis of the ecological footprint of the rice value chain showed that halving food losses could reduce Nigeria's total greenhouse gas emissions by up to 0.4 per cent and thus yield significant environmental benefits.

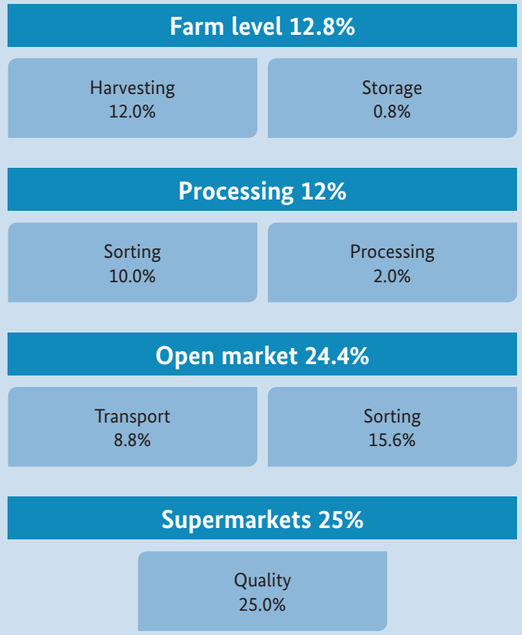
Study 2: Post-harvest losses in the potato value chain in Kenya

Potatoes play a key part in Kenya's food security on account of their comparatively high yield in terms of kilocalories per hectare and the falling productivity of maize, the staple food. They are grown mainly by smallholders, who achieve relatively low yields.

Per season, about 19 per cent (815,000 t) of the Kenyan potato crop is lost. This represents costs to the economy of EUR 109 million annually. More than 95 per cent of these losses are caused by or result from the limited availability or incorrect use of production inputs; for example, local seed may be used that produces potatoes with poor storage qualities, or harvesting equipment can cause damage when used inappropriately. Poor storage at farm level is responsible for around one-tenth of all losses. Promising approaches to reduce losses during production are: a) improved access to and greater use of more disease-resistant varieties; b) communal use of machinery and suitable storage facilities and c) responsible contract farming that incentivises the production of quality potatoes. Farms that have contractual ties with processing facilities have lower losses as a result of better cultivation practices and the contract partners' demand for higher quality. In addition, these farms are not affected by fluctuations in market prices.

The poor quality of the potato crop also affects losses during transport and marketing. Potatoes are packed into large sacks without being sorted and are transported under poor conditions. Around a quarter of all the potatoes that reach the market are already damaged (squashed, mouldy, green), but because demand is high they are guaranteed to sell. The potatoes are paid for by the sack and not by weight, which means that buyers prefer the sacks to be as large as possible. Attempts to introduce standardised packaging sizes and materials to protect potatoes and porters have so far failed because of insufficient signals from the market. Payment based on quality rather than the current price per packaging unit is to be encouraged through marketing regulations.

Figure 2: Damage and loss along the potato value chain in Kenya



Study 3: Food losses in the cassava and maize value chains in Nigeria

Cassava and maize are important staple foods in many African countries, including Nigeria. They are grown mainly by smallholder farmers. In Nigeria most cassava is processed into gari and starch. Losses in gari production amount to 800,000 tonnes (t) per year, while in starch production they total 106,000 t annually. This represents annual costs to the economy of EUR 686 million. Losses along the value chain occur during harvesting (5.0%), as a result of inappropriate harvesting technologies (machetes), because of poor soil conditions (dry and stony) and in the course of storage (moisture 4.5%, rodents 2.5%). In gari processing, losses due to the necessity for peeling are mainly a problem for industrial (rather than domestic) processors, since tubers that are too small or too woody are discarded in industrial facilities. The majority of losses in starch production occur during tuber processing (5.5%) and starch storage (6.3%). Because Nigeria is unable to meet demand from local sources, it is forced to import cereal starch. To reduce losses, it is recommended that better methods of harvesting, peeling and storing cassava are promoted.

In Nigeria maize is processed into flour for human consumption and into animal feed. Losses in the maize value chain cost the Nigerian economy EUR 576 million per year. Significant losses occur before harvesting as a result of pests and diseases. Further losses at farm level arise during harvesting, shelling, storage and transport, and

Damaged potatoes. © GIZ

Market in Kenya. © GIZ

Cleaning the maize by blowing out dust and light impurities. © GIZ/Margret Will

Poor packaging results in losses during maize transport and storage. © GIZ/Heike Ostermann

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The platform will collate and coordinate information on measuring and reducing food loss and waste from existing initiatives such as for example the Save Food Initiative and the Food Loss and Waste Protocol. The aim is to cast a spotlight on food loss and waste as a global problem of great economic, environmental and social importance, to coordinate and harmonise current activities to tackle the issue, and to improve collaboration between national and international organisations, businesses and non-governmental organisations in this field.

Basing its actions on the 'food use-not-waste' approach, the platform sets out to promote relevant interests, advise on joint activities and help countries achieve national targets on reducing food loss and waste.

Maize losses in the marketplace. ©GIZ/ Heike Ostermann

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International initiatives to reduce food losses

To prevent food losses, it is important to be able to quantify them, describe them and pinpoint their specific causes. Hitherto, however, the data available has been inadequate, and coordination between stakeholders on data collection has been unsatisfactory. A number of global initiatives have therefore been launched with the aim of identifying and standardising suitable methods for collecting, organising and analysing data from different stakeholders. This will play a significant part in reducing food losses.

Initiative 1
African Postharvest Losses Information System (APHLIS & APHLIS+)

Calculating food losses and publishing and disseminating the data were proving a particular problem for national agencies in sub-Saharan Africa. The African Postharvest Losses Information System (APHLIS) was launched in 2008 to address this. APHLIS is a computer-based tool for determining post-harvest cereal losses in Africa. The network, in which 38 African countries now collaborate, was started as a project of the European Commission with support from the Natural Resources Institute, University of Greenwich (NRI) and was coordinated initially by the German Federal Agency for Agriculture and Nutrition (BLE).

The aim of the APHLIS initiative is to network local experts in eastern and southern Africa and to create a database on food losses. Local experts can use the online platform to input data into the system and use the programmes and statistics that are available on the website to calculate food losses. APHLIS uses the seasonal data provided by experts and combines it with evidence-based post-harvest loss profiles to create mathematical models for forecasting post-harvest losses. This enables it to forecast cumulative annual percentage losses for cereals at the level of sub-national administrative units such as provinces or regions.

Under local conditions the quantity and nature of what is lost is often unclear.
© GIZ/ Ollivier Girard

The improved data basis will be used to identify opportunities and problems in a country's agricultural system; it will assist in agricultural policy formulation as well as in planning investment and projects more strategically. This has the potential to increase the effectiveness of value chains and improve food security.

APHLIS+, an expanded and improved version of APHLIS that is being funded by the Bill and Melinda Gates Foundation, is due to be produced within the next three to five years. The aim is for APHLIS+ to become the "industry standard" in the regions concerned, involving a wide range of stakeholders and donors. The coverage of crops will be expanded so that the system will be able to forecast post-harvest losses not only for cereals but also for pulses, roots and tubers, and plantains. Data collection will be improved by accessing additional sources of data. This will enable the system to be expanded to include alert mechanisms for aflatoxin contamination and incidences of the larger grain borer, a serious pest in maize.

Initiative 2
Save Food: Global Initiative on Food Loss and Waste Reduction

The Save Food initiative was launched by the Food and Agriculture Organization of the United Nations (FAO) and Messe Düsseldorf at the Interpack 2011 trade fair for the packaging and processing industry. It aims to reduce food loss and wastage.

The initiative currently (as at 2015) has 120 partners from the food industry – most of them in the packaging sector; 230 non-governmental organisations are also involved. The United Nations Environment Programme (UNEP) joined the initiative at the end of 2012. The Save Food initiative functions as an international multi-stakeholder platform for addressing the issue of food losses and –waste. It provides a global framework and pioneering impetus for activities at regional, national or local level. One of its priorities is to link research and financing organisations with the private sector. It also seeks to raise awareness among consumers. The website of the Community of Practice on Food Loss Reduction (CoP), a result of the first joint project of the FAO, IFAD and WFP[1], provides a platform for dialogue, exchange of information and project coordination.
In addition, through its worldwide communication strategy and outreach work, Save Food helps to raise public awareness and supports publication of scientific studies on food security issues. A key activity in this regard is the Think.Eat.Save campaign launched by UNEP and the FAO, which is now supported by numerous non-governmental organisations. Amongst other activities a 'Definitional Framework of Food Loss' has been published; the definitions it contains are intended to standardise the terminology used by different stakeholders. The initiative also supports research into food loss and waste. Save Food has developed a methodology for collecting data from value chain case studies that has already been tested in the banana, maize, milk and fish sectors in Kenya.
As part of the Save Food initiative and the Global Strategy for Improving Agricultural and Rural Statistics, the FAO is currently working on an indicator for quantifying food losses, the Global Food Loss Index (GFLI).

1 Food and Agriculture Organization of the United Nations (FAO), International Fund for agricultural development (IFAD), World Food Program (WFP)

Rice before and after husking. ©GIZ/ Ollivier Girard

The FAO Global Strategy to Improve Agricultural and Rural Statistics

Under the Global Strategy to Improve Agricultural and Rural Statistics the FAO plans to collect internationally comparable data on food losses. Studies of this issue have shown that statistical quantification of food losses poses major methodological challenges and is both time-consuming and expensive. An index method of collecting data on food losses has been developed and field-testing of it is due to be completed by the end of 2016.

The index is based on a model that uses observable variables that are likely to influence food losses (e.g. road density, weather, incident of pests) to calculate loss rates for specific commodities and countries over time. Data on these variables are available from several sources including country statistics, FAOSTAT, WFP's Logistics Capacity index, World Road Statistics, etc.
The GFLI is intended to serve as an indicator for achieving the twelfth Sustainable Development Goal: 'Ensure sustainable consumption and production patterns'. The first version of the indicator is now ready and is being field-tested.

Initiative 3
Food Loss and Waste Protocol

The Food Loss and Waste (FLW) Protocol is a multi-stakeholder initiative that seeks to devise a global standard for quantifying and monitoring food loss and waste.

The standard, which has been developed under the auspices of the World Resources Institute (WRI), aims to establish internationally consistent definitions and data collection methods in connection with the measurement of food loss. It does not define what specific processes or activities generate food loss and waste but instead seeks to identify possible routes and destinations of food loss.

The standard will enable a wide range of entities – countries, companies and other organisations – to collect, report and analyse quantitative data on food loss in a practical and internationally consistent form and thus identify where and when food loss occurs. This will help to establish how food loss should be addressed internationally and to identify opportunities for cooperation between a range of institutions, donors and initiatives.

The FLW Protocol also supports the Save Food initiative launched by the FAO and Messe Düsseldorf. The Food Loss & Waste Accounting and Reporting Standard was published by the Food Loss and Waste Protocol and is available for use. The aim is for the standard to be widely used in all parts of the world.

Initiative 4
Champions 12.3

Sustainable Development Goal (SDG) Target 12.3 aims to halve per-capita global food waste by 2030 and reduce food losses during production and processing.

To achieve this target, the 'No more Food to Waste' conference held in Den Haag in June 2015 proposed that the Champions 12.3 group be set up. Champions 12.3 is a voluntary inclusive coalition of representatives of governments, businesses, international organisations, research institutions and civil society dedicated to accelerating progress toward achieving SDG Target 12.3.

Partners are encouraged to demonstrate how food loss and waste can best be avoided, to raise the profile of the issue in both private-sector and public debate, and to create the enabling conditions for sustainable reductions in food loss and waste. Champions 12.3 is intended to complement other international initiatives such as Save Food and Think.Eat.Save.

The coalition enables members of Champions 12.3 to achieve goals together, to support each other, to learn from experts, to identify cost-effective solutions and hence to draw public attention to their global leadership skills.

Initiative 5
G20 Technical Platform on the Measurement and Reduction of Food Loss and Waste

The meeting of G20 agriculture ministers held in Istanbul in 2015 announced the launch of a Technical Platform on the Measurement and Reduction of Food Loss and Waste managed by the FAO, IFPRI and other international organisations.

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Improved maize store, Ghana. © GIZ/Heike Ostermann

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Losses and poisoning as a result of aflatoxins

It is estimated that some 4.5 billion people in developing countries unknowingly ingest aflatoxins with their food. Consumption of products contaminated with aflatoxins regularly causes acute and potentially fatal poisoning. Aflatoxins are toxins produced by a mould that is most frequently found in maize and groundnuts but also affects other cereals, oil seeds, nuts and spices. They are not destroyed by cooking.

The mould *Aspergillus flavus* infects the plant in the field and remains in the crop after harvesting. There are many other fungi (species of *Aspergillus*, *Alternaria*, *Fusarium*, *Penicillium*, etc.) that form other mycotoxins – including ochratoxins and fusarium toxins such as the fumonisins – on cereals, fruit, vegetables, etc. Mycotoxins develop both in the field and in the store. Damage before and during harvesting encourages fungal growth, as does infestation of stored crops by insects. High temperatures and moisture during and after harvest and in the store facilitate the spread of moulds and other fungi and therefore the formation of additional mycotoxins. Aflatoxin contamination cannot be detected visually but there are indicators that suggest that it may be present. These indicators, which vary from product to product, include discolouration, a mouldy smell, and unusually high moisture content. Actual contamination (the type and quantity of aflatoxin) can only be verified by relatively expensive physical - chemical laboratory testing. There are also rapid aflatoxin tests that can be used, for example, to check incoming goods, but for a number of reasons they are often not available. For reliable testing it is important to have a representative and sufficiently high number of samples, because the aflatoxins may be unevenly distributed in the harvested or stored product (e.g. maize).

Aflatoxins are present even in the mould spores and some are highly toxic. In principle all mouldy foods can contain mycotoxins. Contamination can also be present without any outwardly detectably formation of mould. Some aflatoxins are carcinogenic: they can cause liver cancer and other forms of cancer. Aflatoxins reduce nutrient uptake, weaken the immune system and thus increase susceptibility to HIV and malaria. In children they cause stunted growth and delayed development.

Correct handling and storage after harvesting reduces the risk of aflatoxin poisoning. © GIZ/Klaus Wohlmann

As well as being harmful to health, aflatoxins cause considerable economic damage. The FAO estimates that around 25 per cent of the world's cereal harvest is contaminated with aflatoxins. In addition to being toxic, aflatoxins frequently impair the taste, smell, texture and colour of food.

Many countries – especially the EU and North America – have defined strict limits for aflatoxin levels in food and feed. This creates a significant barrier for agricultural products from other countries seeking to access these markets. Goods cannot be imported unless the exporter can prove that their aflatoxin content does not exceed the very low permissible limit and this is confirmed by tests at the border. One study estimates that African exporters of cereals, dried fruit and nuts are incurring annual losses of around US$670 million as a result of the European limits alone (Otsuki et al., 2001). Losses on a similar scale arise because export goods are destroyed and the exporter is responsible for the transport costs incurred.

In producer countries, however, non-exportable goods are often not destroyed but sold on the national market. Smallholders are often unwittingly exposed to the toxins both via the food they produce for their own use and via the staple foods sold on the market. In addition, livestock owners in producer countries often lose income as a result of using animal feedstuffs that are contaminated with aflatoxins and hence cause higher death rates and poor feed conversion and make animals susceptible to disease. Cows pass on the toxins they take in with such feed in their milk in a process known as carryover.

There are a number of ways of preventing aflatoxin contamination. For example, crops can be protected by inoculating the soil with strains of *Aspergillus* that do not produce toxins (see the Aflasafe case study). Of utmost importance is the application of good agricultural practice (GAP) before and after harvesting and during storage (healthy soil, protection of crops and stored goods, dry storage). Aflatoxin build-up in the field can be reduced by using stress- and aflatoxin-resistant varieties and preventing insect infestation. Harvesting crops at the right time, avoiding contact between the soil and harvested produce and immediate thorough drying after harvesting until the produce is ready for storage reduce the formation of aflatoxins. Dry and cool storage conditions prevent mould growth in the store and hence inhibit further aflatoxin production.

Once foods are contaminated, they cannot be decontaminated. It may be possible to use them for other purposes, such as energy generation. A study shows that aflatoxin-free groundnut oil can be obtained from contaminated groundnuts (Emmot & Stephens, 2012). Aflatoxin is a protein, not an oil. The study finds that double-filtered oil is protein-free and hence suitable for human consumption. The press cake that remains after filtration can be mixed with clay. This binds the aflatoxins, enabling the substrate to be used safely as animal feed.

Reducing aflatoxins in food and hence improving marketing prospects requires a systematic approach. It is important to tackle the various aflatoxin-related challenges at a number of points in the value chain. The various relevant stakeholders must also be involved. Steps can be taken to reduce the aflatoxin risk even before the crop is sown; measures should cover the method of production, storage systems and different marketing stages until the produce reaches the end customer. Implementing a systematic approach of this sort in the smallholder context can be difficult if it is seen solely as a task for the farmer. The public sector therefore has an important part to play in areas such as regulation, the development of monitoring systems and the promotion of preventive measures in collaboration with businesses, especially in the export sector. In addition, widespread limitation of the damage caused by aflatoxins can only be achieved with the involvement of the public health sector and rigorous monitoring of the quality of traded food products.

Damage to maize cobs.
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Project:

Aflasafe

Development and marketing of Aflasafe, a product for the biological control of Aflatoxins (Zambia), 2014 – 2015

Scientists at the International Institute of Tropical Agriculture (IITA) in Nigeria have produced a biological aflatoxin inhibitor that is suitable for use by smallholder farmers. The researchers analysed 4,500 strains of the *Aspergillus flavus* mould that occur in Nigeria and found 20 that produce no toxins because they have a genetic defect. These form the basis for the new aflatoxin inhibitor 'Aflasafe'. Sterile sorghum grains are inoculated with the 'good' fungi and then scattered on the field like fertiliser. As soon as they come into contact with moisture in the soil, the moulds grow and spread. Because they grow faster than the toxigenic strains, they gain the upper hand. Farmers who applied the biofungicide to their maize fields experienced an 80 to 90 per cent reduction in aflatoxin contamination.

German development cooperation played a key part in supporting development of this biological control method. Building on this, BMZ is currently financing a project to control aflatoxins in Zambia under the umbrella of its ITAACC programme (Innovation Transfer into Agriculture - Adaptation to Climate Change). For the purpose of the project, various partners including USAID and ZARI (Zambia Agricultural Research Institute) have come together under the umbrella of the Partnership for Aflatoxin Control in Africa (PACA); promoting the local production and marketing of Aflasafe is one of their activities.

Like many sub-Saharan countries, Zambia is experiencing the adverse impacts of aflatoxin contamination on its trade in agricultural products. Soils, crops and some agricultural products from Zambia are often heavily contaminated. In the 1970s Zambia was a net exporter of groundnuts, but it is now very difficult for the country's producers to get their products into the EU market.

The aim of the Aflasafe project is therefore to boost the incomes of smallholder families and the nutritional value of their food and to improve marketing opportunities along the value chain for Zambian producers of maize and groundnuts.

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Analysing and quantifying food losses

The report of the Committee on World Food Security (CFS), 'Food Losses and Waste in the Context of Sustainable Food Systems', emphasises that in order to reduce food losses it is important to identify food loss hotspots along the value chain and devise appropriate and workable ways of addressing them. Research-based methods have in the past been too time-consuming and expensive and were often not suitable to generate information that can be used in local decision-making. Case studies conducted with local stakeholders are a fruitful and inexpensive means of identifying hotspots. They provide a basis for targeted project planning, specific data collection and the development of workable context-oriented solutions. Both the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Food and Agriculture Organization of the United Nations (FAO) have developed methods of assessing food losses along various value chains on the basis of case studies.

All participants can contribute their experience – producers drawing up a loss matrix.
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GIZ: Rapid Loss Appraisal Tool (RLAT)

GIZ has designed and piloted the Rapid Loss Appraisal Tool (RLAT) for agribusiness and food value chains with the aim of providing an easily usable methodology for the development of realistic and realisable measures to reduce food loss. In particular, the method is intended to identify food loss hotspots and is designed to serve as a pre-screening for further in-depth studies. It facilitates the development of concrete approaches aimed at increasing food security and upgrading value chains.

The value chain to be analysed is specified by the specific project or client. The tool is based on a number of tried and tested participatory methods which can be used rapidly and easily to collect information systematically, identify stakeholders' perception and assessment of food losses, discuss solutions, and triangulate and validate the findings without the need for elaborate representative surveys or measurements. The RLAT method works with the estimates of various stakeholders along the value chains. These ratings are collected in expert roundtables, stakeholder workshops and focus groups and then compared. Steps are taken to ensure that women are adequately represented. Where possible, transect walks are undertaken and the biophysical properties of samples are analysed. The findings are verified and/or expanded in interviews with key stakeholders.

RLAT has been tested on the maize value chain in Ghana. However, the methodology can be adapted to other value chains, taking account of context-specific differences.

Link to the detailed user guide:
www.donorplatform.org/news-and-media/publications/latest-publications/1522-rapid-loss-appraisal-tool-rlat

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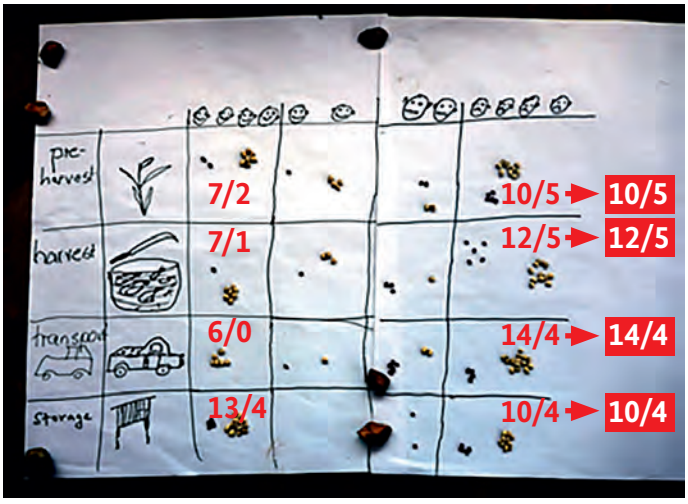
FAO/Save Food: Case studies of smallholder farming and fisheries

As part of the Save Food initiative, the FAO has produced case studies of the most important food value chains in developing countries. The aim was to identify and quantify the main causes of food losses in the value chains and to suggest methods of reducing food losses that are economically feasible, environmentally sound and socially acceptable. The results will also be used to identify opportunities for investment and intervention.

Because case studies only cast light on one specific situation, it is important that the Save Food initiative undertakes as many studies in different locations as possible so that the combined results can provide sound information on significant trends and possible solutions.



Outcome of a focus group: Matrix of the perception of losses.
© GIZ/Heike Ostermann

The value chains that are selected for study need to meet the criteria of predominantly smallholder production, high production output, involvement of processing and urban markets, and integration into an existing value chain programme. During the study a detailed description of the value chain is drawn up: the analysis covers production costs, land use, water use, energy consumption and the social setting. Both surveys and comprehensive observations are used to evaluate food losses. Samples are also taken and analysed at different stages of the value chain.

The case studies that have been carried out so far explore the value chains of maize, bananas, milk and fish in Kenya.

By comparison with GIZ's RLAT method, the FAO case studies rely more heavily on surveys and require standardised methodology and implementation in order to ensure the comparability of results and thus enable a representative database to be created.

Link to the Save Food initiative's case studies:
hwww.fao.org/3/a-at145e.pdf

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