

Rural21

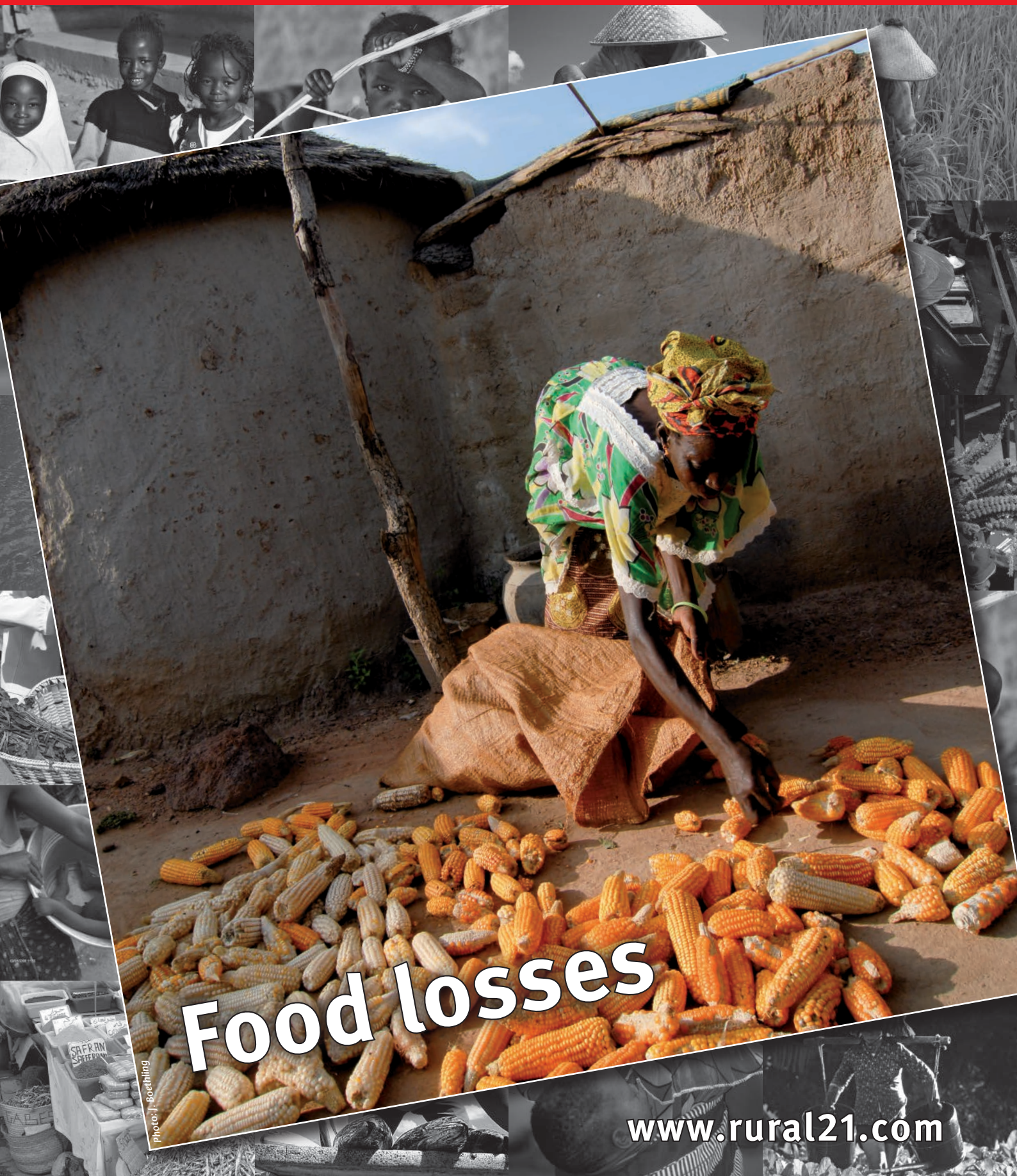
The International Journal for Rural Development

No. 1/2013

Volume 47

ISSN 1866-8011

D 20506 F



Food losses

Photo: J. Boethling

www.rural21.com

Dear Reader,

Roughly one third of the food produced globally for human consumption is lost or wasted – 1.3 billion tons per year. Yet food production must increase by 70 per cent by 2050 if the growing population of the world is to be fed. While critics note that these estimates by the United Nations Food and Agriculture Organization (FAO) are subject to numerous uncertainties, one thing is beyond doubt: every kilogramme of food that is produced but not consumed is one too many. For it embodies valuable, wasted resources such as land, water, agricultural inputs and energy; unnecessary CO₂ emissions were released to the atmosphere, farmers have lost not only income but also a valuable part of their nutrition, and consumers pay the increased prices that result. The losses thus impact on the entire economy – not to mention the repercussions for global food security.

Food losses arise throughout the entire food chain. While in medium- and high-income countries they are mainly a matter of retail and final consumption, in low-income countries they primarily affect the early stages of the food supply chain. Studies have shown that in developing countries more than 40 per cent of all food losses occur at post-harvest and processing levels. The scale of losses varies greatly by product and region, but all agricultural products are affected: fruits and vegetables, cereals, oilseeds and pulses, roots and tubers, dairy products and eggs, meat and fish.

A complex web of causes underlies the numbers. The technological issues on which international cooperation in the realm of post-harvest management concentrated in the 1980s and 1990s are only one aspect; the social and economic dimensions are just as important. For instance, the best storage facilities will have little effect if maize is not harvested at the optimum stage of maturity because farmers are in dire need of cash or food, or no labour is available at the crucial point in time. Similarly, if the plants are bundled and then left standing for several days in the open field until the cobs are harvested and brought to safe storage, then a practice designed to facilitate work and save labour costs will have the main effect of attracting insects and rats and, if unforeseen rain occurs, creating ideal conditions for mould infestation. Usually quality losses are a more complex matter than quantity losses and – expressed in monetary terms – often greater: Farmers lose income opportunities

because they are compelled to sell their low-grade goods in low-value markets. Furthermore, quality loss may also include a decline in nutritional value of products, or even lead to serious health problems such as aflatoxin poisoning.

Many farmers are well aware of the importance of good post-harvest management. What they lack are suitable incentives that make it attractive for them to invest in improved quality of their products. Measures designed to reduce food losses must therefore tackle the entire value chain. This is not a new understanding, and effective approaches have long been defined. The problem is that this field of rural development, as many others, has fallen victim to the decade-long neglect of the sector. The international community recently reinvigorated its efforts to assemble the available knowledge about post-harvest loss prevention and make it publicly accessible – in networks such as the Information Network on Post-harvest Operations (InPhO), the African Postharvest Losses Information System (APHLIS) or the Global Donor Platform for Rural Development. This issue of Rural 21 – and our website (www.rural21.com) – presents these and many further activities and related projects.

It is no coincidence that several of the articles in this issue are concerned with sub-Saharan Africa. For one thing, the post-harvest protection activities of development agencies in the 1980s and 1990s concentrated on that region due to the severe droughts and famine in the Sahel; for another, the losses are particularly high here. It is estimated that the annual value of weight losses in cereal grains in sub-Saharan Africa exceeds the value of total food aid received by the region in the decade 1998–2008. Not least, Africa is the continent that will probably suffer most from the impacts of climate change. This is a factor that, together with food security, will need to be at the forefront of debate on food loss and waste in future.

Have an interesting read,

Silvia Richter



Partner institutions of Rural 21:



News

- 4 Global Food Policy Report 2012: mixed results
- 5 Food corporations not complying with social and environmental standards, says Oxfam

Focus: Food losses

- 6 New approaches needed
- 10 Who does what in post-harvest loss reduction?
- 12 Out of the bag: the hidden value of post-harvest agriculture in a changing climate
- 15 Nigeria: how losses in the maize and manioc value chains impact on the environment
- 16 Tackling post-harvest cereal losses in sub-Saharan Africa
- 19 Better income through improved milk hygiene standards – an example from North Somalia
- 22 Handling fresh vegetable produce from urban gardens
- 24 Post-harvest losses in India: Technical know-how is only one side of the coin
- 26 New developments in stored product protection
- 30 How to reduce aflatoxin contamination in Africa’s agricultural crops – experiences from the Aflacontrol Project



Photo: Bilderbox.com



Photo: R. Hodges



Photo: AVRDC

International Platform

- 32 Marketing local rice to African consumers
- 35 Post-conflict Liberia: Empowering youth, opening up perspectives

Scientific World

- 38 Water storage: a contribution to climate change adaptation in Africa
- 42 Mapping hotspots of marginality for area identification



Photo: J. Ziebulu

Global Food Policy Report 2012: mixed results

Talk about food security in global and regional bodies was abundant in 2012. But what has really been achieved? This issue is explored in the Global Food Policy Report 2012, which was presented by Shenggen Fan, Director General of the International Food Policy Research Institute (IFPRI), in Washington D.C. in mid March 2013.

On the plus side, it can be said that some African countries made noteworthy progress transforming agriculture into a more productive and sustainable sector. In emerging economies such as Brazil, China, and India, agricultural spending, including investments in agricultural research, continued to increase. The private sector enhanced

its commitments to global food security through active engagement in the Business 20 (B20) summit and with G8; and numerous development agencies in Europe and the USA scaled up their investments in agriculture, food security and nutrition.

On the minus side, numerous commitments were not fulfilled. Only a handful of African countries met their ten per cent target of agricultural spending as a share of the national budget; increased agricultural spending was often used by emerging economies and some African countries to subsidise inputs and outputs, leading to trade distortions, overuse of fertiliser, water, and energy, and a neglect of investments in

other areas such as rural development. Several countries continued to use trade bans, which exacerbate global food price volatility. The United States and the European Union proposed new agricultural policies that could potentially distort world agricultural and food markets, leading to adverse effects on small-holder farmers in developing countries. The Report also mentions the disappointing international negotiations on climate change in December 2012 which ignored the agreement reached in Cancun, Mexico, in 2011 to decide on an agricultural work programme.

■ A fragile global food system

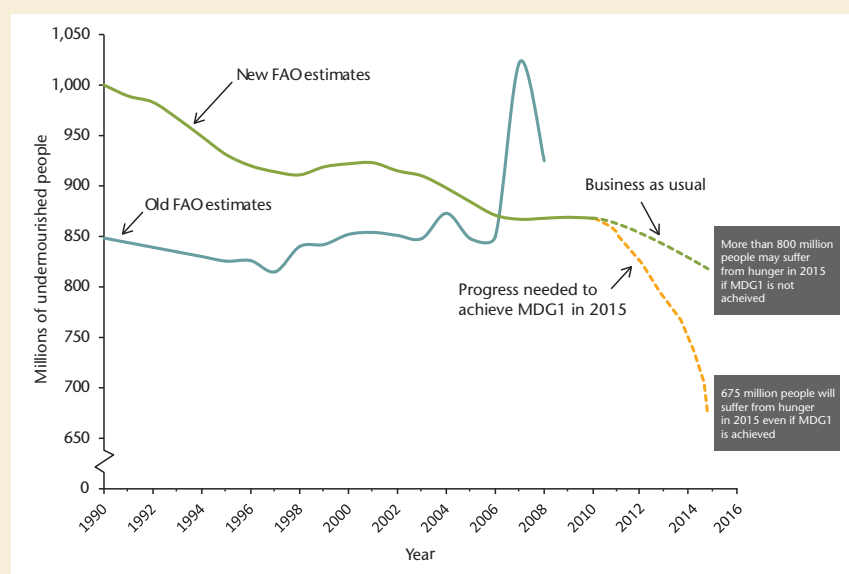
The 2012 droughts in Australia, Central Asia, Eastern Europe, and the United States led to tighter cereal supplies and, subsequently, a spike in world cereal prices. Upward pressure on food prices will also have an impact on and implications for global food security in 2013, the Report states. The increase in international cereal prices was especially problematic for countries that depend on cereal imports, in particular in Central and South America and Central Asia. In the Sahel region, too, prices for many coarse grains soared in 2011 and 2012, owing to a combination of drought, civil unrest, and locust infestation. In Burkina Faso and Mali, for example, millet prices rose by 66 and 63 per cent respectively, compared with 2011. Prices continue to be relatively high owing to flooding and political insecurity in the region, threatening the food security of nearly 19 million people, Shenggen Fan predicts.

Violent conflict played a role in a number of African countries – above all in Mali, the Democratic Republic of Congo and Somalia, resulting in the displacement of an approximate total of 2.7 million people. In the Arab region, civil war in Syria has led to a refugee crisis that is being compounded by a food

Hidden hunger should not be underestimated

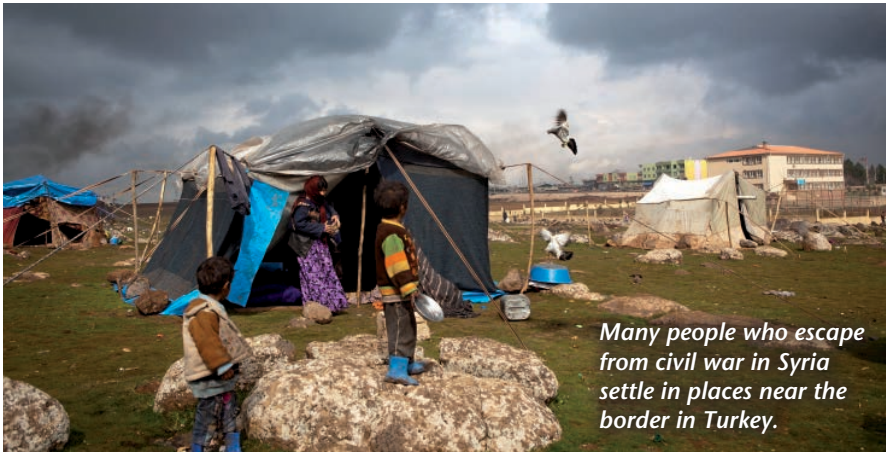
Estimations of the UN Food and Agriculture Organization (FAO) on malnutrition fall short of what is really the case, IFPRI Director General Shenggen Fan criticises in the Global Policy Report 2012. While the methodology and data were revised (see Graph), representing important steps towards obtaining a more comprehensive measure of food security, the numbers only reflect the quantity of food in people's diets (specifically kilocalories), not the quality (vitamins and minerals). It is believed that a large number of people suffer from micronutrient deficiencies, called "hidden hunger", which is not captured by the new measure, Fan claims.

Estimates and projections of undernourished people world-wide, 1990 – 2015



Sources: Old estimates are from Food and Agriculture Organization of the United Nations (FAO), *The State of Food Insecurity in the World* (Rome, various years); new estimates are from FAO, *The State of Food Insecurity in the World 2012* (Rome, 2012); author's projections are based on data from FAO and the United Nations.

► For more information on "hidden hunger", visit www.rural21.com



Many people who escape from civil war in Syria settle in places near the border in Turkey.

Photo: L. Karil/latif

crisis. While food security in Tunisia has stabilised, the situation has worsened in Yemen and, to a lesser degree, in Egypt and Libya.

■ Regional transformations with a global impact

The report also stresses a number of significant food policy developments on the regional level – partly with fundamental impacts on global food security. For example, numerous African countries continued showing strong annual agricultural growth rates (e.g. Angola, Botswana, Ethiopia, Ghana, Liberia, Malawi, Rwanda and Tanzania), fuelled largely by more investment in agriculture, increased use of fertiliser, and the adoption of high-yielding crop varieties, together with more friendly macroeconomic policies. Poverty rates in these countries have declined, but rates of hunger and malnutrition remain high.

For China, the year 2012 was a turning point. After many years of near self-sufficiency in major grains, the country had to import a total of around 12 million tons of rice, wheat and maize. It has to be feared that in future, China will be pursuing protective trade measures, with potentially negative implications for farmers in other developing countries and for the global agricultural trade. But the country's public spending on agriculture has developed strongly and is now outpacing that of Brazil and India.

The Arab world is one of the few regions where hunger levels have increased in recent years. Economic growth in the region has been persistently slow, and child malnutrition is high. To address food insecurity, governments have mostly continued the policies adopted during the 2008 global food crisis and the 2010-2011 uprisings, such as increased public sector wages and subsidies for fuel and food

■ What does the future hold?

Poor countries will continue to be hard hit by a number of ongoing economic and environmental shocks. Therefore, social systems and ecosystems should be made resilient to both natural disasters and human induced crises; dry areas deserve special attention as they are home to half of the world's poor and hungry people, and climate change will make them even more vulnerable. Efforts to protect and promote human health should go hand in hand with efforts to improve the health of livestock, crops, and ecosystems. And last but not least, the focus of food policies should shift from cutting hunger towards eliminating it completely – within a clear timeframe and with mechanisms for holding countries, international institutions, and other relevant actors accountable for meeting this goal. (sri)

► www.ifpri.org

Oxfam criticises food companies

The world's ten largest food corporations are still far from fulfilling social and ecological standards. This is the conclusion that the "Behind the Brands" survey of the non-governmental organisation Oxfam arrives at. The companies examined in the survey were Coca-Cola, Danone, Unilever, Kellogg's, Mars, Mondelez, Nestlé, PepsiCo, General Mills and Associated British Food. Oxfam made an assessment of the corporations' self-proclaimed targets in the fields of industrial relations law, the rights of small-scale farmers, women's rights, handling of water and land, climate change and transparency.

Oxfam criticises that most companies do not provide small-scale farmers with equal access to their supply chains. Neither had any of the firms publicly committed themselves to paying farmers a fair price for their produce. Furthermore, companies were not taking sufficient steps to curb massive agricultural greenhouse gas emissions responsible for climate changes now affecting farmers. Oxfam also highlights the lack of appropriate standards to protect local communities from land and water grabs along their supply chain. Here, corporate goals would be especially important since these companies process agricultural commodities such as palm oil, soy and sugar. Discrimination against women within the value-added chain is also insufficiently addressed by the companies surveyed, Oxfam claims.

"It is high time for the food corporations to assume more responsibility for their enormous influence on the lives of poor people," said Frank Braßel, Deputy Campaign Director of Oxfam Deutschland. "Eighty per cent of people suffering hunger live in rural areas. It is from there that the companies procure their ingredients." (sri)

► www.oxfam.org

Tackling food losses: New approaches needed

In the 1980s and '90s post-harvest protection featured prominently in international cooperation, but subsequently the emphasis placed on it diminished. The debate on rising food prices and the use of limited resources has placed it high on the political agenda again. But have the priorities remained unchanged in the intervening years? Can the lessons learnt still be used, or do we need to start again from scratch? Our contributors report on the practical experience of German development cooperation.

Food shortages, food price rises and the impacts of climate change on agricultural production are once again topical issues. In consequence, policy-makers, researchers and the private sector are turning their attention to the promotion of agriculture in developing countries. In 2009 the G8 countries launched the L'Aquila Food Security Initiative (AFSI), under which they pledged to provide 22 billion US dollars between 2010 and 2012 for measures that would help to permanently resolve the food crisis. The German chancellor, Angela Merkel, promised that during this period Germany would contribute three billion dollars for rural development and food security. The German Federal Ministry for Economic Cooperation and Development (BMZ) has set out its targets for the promotion of rural development and food security in a ten-point programme. Among other issues, the programme explicitly refers to "improving post-harvest protection".

The UN Food and Agriculture Organization (FAO) estimates that

Heike Ostermann
 heike.ostermann@giz.de

Bruno Schuler
 bruno.schuler@giz.de
 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
 Eschborn, Bonn, Germany

around 30 per cent of the food harvested worldwide is lost or wasted. This is equivalent to a staggering 1.3 billion tons (FAO, 2012). Similar figures were being quoted two decades ago and the present data basis is weak. What is clear, however, is that food losses are making a significant contribution to the global food crisis.

Food losses occur along the entire food supply chain (FSC), including production, storage, processing and distribution, from the field to the plate. They are unacceptable from both economic and environmental points of view since they vitiate investment that has already been made in agricultural inputs, labour and natural resources such as soil and water.

■ Two sides of the coin

Food waste involves products that are ready to eat but that are not in fact used for human consumption. It is particularly significant in the industrialised countries and is becoming an increasing problem in newly industrialising ones. **Food losses**, on the other hand, occur between harvest and sale, often in developing countries. The wastage close to home and the losses in the developing country both have a similar effect: they exacerbate food security problems and add unnecessarily to the

pressure on the natural factors of production. However, the causes of wastage and loss are very varied and a wide range of stakeholders and institutions are involved: an assortment of political and technical measures is therefore required to tackle the problem. This article looks specifically at plant-based food losses in the developing countries; it should not be forgotten that animal products – meat, fish, milk, eggs – are also affected by losses throughout the value chain, but these have been of less importance in development cooperation projects (see also Table on page 8).



■ Post-harvest protection in development cooperation: the experience of the '80s and '90s

As an issue triggered by the severe droughts and famine in the Sahel, post-harvest protection played an important part in German and international development cooperation in the 1980s and '90s. During this time BMZ supported several national food security projects involving state storage of food supplies (Burkina Faso, Mali, Mauritania, Niger) and a number of other projects in Africa (Benin, Egypt, Ghana, Kenya, Madagascar, Malawi, Tanzania, Togo and Zambia) that included post-harvest protection components. Working with national partner organisations, farmers and field staff, new schemes were devised and disseminated. Various research institutes and universities in the participating countries and in Germany also contributed (among them the Julius Kühn-Institut in Berlin – which was then the Federal Biological Research Centre; see also the article on pages 26–29). This work typically involved introducing new techniques and adapting traditional processes in order to improve stor-



A farm worker storing harvested maize in a silo in Nhamuka village, Mozambique.

Photo: FAO/P. Thekiso

age hygiene and prevent infestation. Chemical treatment and fumigation of stored produce were also used if other approaches looked unlikely to succeed.

As well as supporting national crop protection projects, German development cooperation between 1983 and 1998 also supported an integrated Africa-wide campaign against a widespread storage pest, the larger grain borer (*Prostephanus truncatus*); this was achieved via promotion of a trans-regional project with priority areas in Benin, Ghana, Malawi, Tanzania and Togo. *Prostephanus truncatus* – an auger beetle of the *Bostrichidae* family – was brought to Africa from Central America in the late 1970s. Having no natural enemies, it multiplied rapidly and inflicted considerable damage on stored maize and dried manioc. In collaboration with the International

Food losses – an important topic in GIZ projects

Even if specific post-harvest-management projects, as in the past, do not exist any more, the topic food losses is addressed in many GIZ projects dealing with rural development, agricultural promotion and especially promotion of agricultural value chains and strengthening resilience of farmers under changing climatic conditions.

For the **Baghlan Agriculture Project in Afghanistan** the development of value chains of wheat, potatoes, fruit and vegetables is a major concern and the project aims that at least 900 enterprises have recorded a significant increase in operating income due to improved storage/processing of market products in Baghlan.

The **African Cashew Initiative** is a jointly funded programme of BMZ (German Federal Ministry for Economic Cooperation and Development), Bill & Melinda Gates Foundation and private-sector partners, and implemented, amongst others, by GIZ. It addresses food losses in cashew and other value chains and aims for improvements in production and best practices for harvesting and post-harvest handling in all participating countries (Benin, Burkina Faso, Ivory Coast, Ghana, Mozambique).

The objective of the **“Market Oriented Agriculture Programme”** (MOAP) in **Ghana** is to improve the competitiveness of agricultural producers and other agricultural actors in processing, trade and services on national, regional and international markets. Through better market infrastructure at the important wholesale market in Techiman, the quality of maize and the reduction in grain moisture is improved. Furthermore, the exportable share of pineapple is risen nation-wide through improved quality, reduced losses and fruit rejects and improved market access.

In **Bolivia**, the **“Programa de Desarrollo Agropecuario Sustentable”** (Sustainable Agricultural Development Programme) aims at improving resilience of smallholder farmers with regard to changing climate conditions. The reduction of post-harvest-losses is one of several options to achieve this goal. The value chains concerned are fruit, vegetable and corn.

Other projects dealing with post-harvest management are in Ethiopia, Laos, Nepal, Nicaragua, Pakistan, Philippines, Usbekistan and Vietnam.

Institute of Tropical Agriculture (IITA) and other international research centres (NRI – Natural Resources Institute, UK; KARI – Kenya Agricultural Research Institute; IIBC – International Institute of Biological Control, UK) the predator *Teretriusoma nigrescens* was introduced to West Africa from its original home in Central America. It was released first in Togo in 1991 and subsequently in other African countries.

The projects of that period had two main aims. Firstly, they were designed to help the state grain agencies of the Sahel countries provide food in areas in which there were shortages by promoting storage structures, storage management and market information systems. Secondly, they set out to substantially improve the protection of grain, maize, cassava, yams, sweet potatoes and beans stored by village

communities and farming families. The specific roles of men and women, especially in connection with the production and post-harvest handling of roots and tubers, were analysed in detail and taken into account in the intervention strategies.

The specific activities included testing different materials and structures for the storage of grain and maize. Exchange visits enabled farmers to learn about different types of storage and hence to identify the type that they would be best advised to build for their own purposes. In some West African countries hundreds of storehouses of different sizes and types were built to provide better medium- and long-term protection for harvested produce that could then serve as a food reserve. In addition, through a range of dialogue and training measures information about better storage and post-harvest management was disseminated and research findings were passed on to multipliers and farmers.

■ The path to the systemic approach

In the 1990s it was already clear that the ideas put forward were not being accepted everywhere and that the expected success was not materialising (Bell, Mazaud, Mück, 1999). Consideration was therefore extended to socio-economic and socio-cultural conditions; this led to the development of valuable post-harvest protection schemes utilising measures that were widely accepted, feasible and adapted to local conditions. The focus was on the economic viability of the measures and their impact on the producer households' standard of living. From a nuanced analysis of types of loss it was evident even then that the loss figures quoted in the literature were frequently too high. „The widespread practice of continuous withdrawal of maize from storage for consumption or sale throughout the storage period leads to

Losses of certain product groups at different stages of the food supply chain (FSC)

Product group	Loss (%)	Stages (FSC)	Region	Source
Cereals	10–15	Transport, processing, storage	worldwide	1
Rice	2–40	Post-harvest	Asia	1
Maize	7–100	Post-harvest	Africa	1
Maize	9–40	Post-harvest	Latin America	1
Sorghum	0–40	Post-harvest	Africa	1
Roots and tubers	10–60	Post-harvest	Africa	1
Roots and tubers	22–33 (26–40)	Post-harvest, storage, processing (incl. distribution)	Africa, Asia, Latin America	2
Fruits and vegetables	33	Whole chain, without consumer	Worldwide	1
Fruits and vegetables	10–50	Post-harvest	Africa and Asia each	1
Fruits and vegetables	30–34 (42–51)	Post-harvest, storage, processing (incl. distribution)	Africa, Asia, Latin America	2
Milk	8–11 (16–21)	Post-harvest, storage, processing (incl. distribution)	Africa, Asia, Latin America	2
Meat products	5–6 (10–13)	Slaughter, storage, processing (incl. distribution)	Africa, Asia, Latin America	2
Fish and seafood	14–15 (24–30)	Post catch, storage, processing (incl. distribution)	Africa, Asia, Latin America	2
Fish	1–5, 3–17, 20–40	Post-harvest small-scale	Selected fish species in African countries	3
Fish, captured and cultivated	10	Post-harvest (weight)	Global	4

Sources:

1. Priefer, C., Jörissen, J., 2012: ITA-Monitoring „Frisch auf den Müll“. Verringerung der Lebensmittelverluste als Ansatz zur Verbesserung der Welternährungssituation. Karlsruhe: ITAS des KIT Pre-Print: 22.11.2012
2. Gustavsson, J., van Otterdijk, R., et al., 2011: Global food losses and food waste. Extent, causes and prevention. FAO
3. Akande, G., Diei-Ouadi, Y., 2010: Post-harvest losses in small-scale fisheries. Case studies in five sub-Saharan African countries. FAO Fisheries and aquaculture technical paper, 550
4. FAO, 2013: Fisheries and Aquaculture Department, Reducing post-harvest losses

the actual storage losses being overestimated,” wrote Bell et al. (1999) based on the fact that the 30 per cent loss in farm maize stores found in Togo after six months therefore corresponded to some 17 per cent of the quantity put into the store (Pantenius 1988).

Building on the concept of integrating protection of stored produce and storage management on the one hand and socio-economic conditions on the other, the system approach to

This maize is infested with the larger grain borer.



Photo: R. Hodges

*A grain silo in Mutwaathi,
eastern Kenya.*

post-harvest activities was developed by the FAO, GTZ and partners in the mid-1990s (on the basis of experience in Ghana, Kenya and Zambia and influenced by the Agenda 21). This was a multi-disciplinary and participative approach that involved all stakeholders at all stages of the “post-harvest chain”. The focus was no longer on pests and technical problems but instead on the people affected by the issues (see “From biological control to a systems approach in the post harvest sector”, IITA / GTZ meeting 1997; Borgemeister et al., 1999). However, the decreasing project activities at that time did not offer much opportunity to implement this concept.

■ What is now the way forward?

Today the perspective has widened to include the causes of food losses and to consider losses not only at producer level but also along the entire value chain, whether during storage, transport, processing or the various stages of marketing. Measures to reduce loss must therefore take account of the entire value chain and focus on the particular hot spots at which the largest losses occur and the most effective measures can be put in place. This is highly depending on the produce and the regional post-harvest conditions. Planning and implementing loss reduction measures needs to involve many different players in both the public and private sectors. The desired result will not be achieved if storage facilities are built without an adequate transport infrastructure, without market information or without further processing opportunities, and technical innovation without prior cost/benefit analysis, without capacity building and without a sound gender approach is unsustainable. In this regard GIZ will closely cooperate with the “Save Food



Photo: FAO/Thomas Hug

Initiative” (www.save-food.org), initiated by Messe Düsseldorf and FAO in 2011 (see also pages 10–11). Complex links and interrelationships need to be identified and incorporated into the measures that are devised. For example, this is the case with the analysis of losses, which now needs to include the environmental footprint of production (see also the article on page 15).

In order not to reinvent the wheel, GIZ has started to connect to main stakeholders in the field of post-harvest protection: in June 2012 it held a seminar entitled “Food losses concern us all” at which key German institutions from research, politics and the private sector exchanged views and planned further collaboration. In July 2012 GIZ

and the Global Donor Platform for Rural Development held a “virtual briefing” on post-harvest losses at which the most important international organisations such as the FAO, the World Bank and the African Development Bank and various national institutions such as the Natural Resources Institute (NRI) and the Swiss Agency for Development and Cooperation (SDC) discussed their measures and strategies for post-harvest losses (www.donorplatform.org/postharvest-losses/virtual-briefings). Other “virtual briefings” are planned. Nowadays GIZ is implementing several projects on rural development and sustainable agriculture together with national partner organisations which integrate post-harvest activities (see Box on page 7).

Comprehensive information

In 1996, to facilitate international discussion of and access to the most important documents on post-harvest protection, the FAO, working with GTZ and the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), set up the internet platform INPhO (the Information Network on Post-harvest Operations), which is still accessible (www.fao.org/inpho). In view of the renewed interest in the issue, GIZ will shortly be making its most important publications, booklets and reports available to professionals worldwide in digital form at the website of the Global Donor Platform for Rural Development (www.donorplatform.org/postharvest-losses).

Further information and details of the references mentioned in this article can be found at www.rural21.com.

Who does what in post-harvest loss reduction?

The network of actors working on the reduction of post-harvest losses is complex and not easy to understand at first glance. This article attempts to give an orientation on who the actors are, how they are interconnected and what important aspects they are dealing with. No matter what kind of actor, all of them are eager to contribute to minimising food losses to keep harvest products in the value chain, both to strengthen food security and to reduce the waste of inputs and resources during production.

■ Multilateral organisations

At the level of multilateral organisations the following actors are aiming to reduce food losses. To start with, the **World Bank** (WB) strives to foster technology adoption and private sector involvement. The project AgResults (formerly known as the agricultural pull mechanism) tries to reach these goals through co-operation with e.g. the UK Department for International Development (DFID), the Canadian International Development Agency (CIDA) and the Bill and Melinda Gates Foundation. In addition to this, the study "Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa" (2011), in collaboration with the Natural Resources Institute (NRI) and the United Nations Food and Agriculture Organization (FAO), intends to close the knowledge gap, raise the profile of post-harvest losses (PHL) and provide policy recommendations.

The **International Fund for Agricultural Development** (IFAD) concentrates its activities on value chain analysis and financing projects.

In 2009, the **World Food Programme** (UN WFP) installed the four-year "purchase for progress" (P4P) project, which is a market incentive for smallholders. It includes purchase from local traders, rapid quality checks on the farms and trainings provided by the FAO and NGOs.

The plans and goals of the **African Development Bank** (AfDB) are summarised in the AfDB Programme for Post-Harvest Loss Reduction. It aims to reduce poverty and to push sustainable food security on the medium scale by reduction of physical losses, improved food availability and enhanced product quality. This is to be reached by investments in rural infrastructure that facilitate supply-chain efficiency as well as strengthening post-harvest

and agro-processing technologies. The **African Agribusiness and Agroindustries Development Initiative** (3ADI) takes up this approach and widens its goals in co-operation with other multilateral organisations to increase agribusiness and agroindustries. It therefore refers to investments being required for "skills and technologies needed for the post-production segments of agriculture value chains" as a pillar of its strategy.

The **Food and Agriculture Organization of the United Nations** (FAO) assists member countries in meeting their PHL-reduction goals. In building educational capacity and by providing good practice examples for farmers, improvement is being achieved at local level. Co-operation with other actors is manifold. Through co-ordination by the **Information Network on Post-harvest Operations** (INPhO) and the initiative of the Save Food Network (see page 11), governments and organisations can benefit from the FAO's competences.

The **African Union** has introduced the **Comprehensive Africa Agriculture Development Programme** (CAADP). This programme sets ambitious economic growth goals to generate wealth through agriculture-led development in African countries. PHL are addressed in the second of its four pillars. Storage, packaging and handling technologies are sought to turn the negative economic effects of food losses into additional resources becoming available on the market.

The **Global Donor Platform for Rural Development** is a forum of multilateral donors, international financing institutions, inter-governmental organisations and development agencies. Its workstream on PHL is a platform for professionals to exchange and explore the possibilities for donors to tackle PHL and food waste to reach aid efficiency.

■ National actors

As well as multilateral organisations, many different national actors have programmes to reduce PHL. Some of them will be mentioned in the following section as examples.

The **German Federal Ministry for Economic Cooperation and Development** (BMZ) has launched a ten-point programme on rural development announcing action to support and improve PH management, create public awareness and demonstrate the benefits of the reduction of food losses after harvest and along the food value chain. The **Deutsche Gesellschaft für Internationale Zusammenarbeit** (GIZ) is implementing the BMZ's policy by organising thematic workshops, elaborating concepts and carrying out several country studies on PHL. Furthermore, the reduction of food losses is addressed in projects on value chain development and other development projects that are carried out in partner countries.

The **German Federal Ministry of Food, Agriculture and Consumer Protection** (BMELV) campaigns to reduce food waste during retail and distribution and at consumer household level. Its agency, the **Federal Office for Agriculture and Food** (BLE), hosts the **African Postharvest Losses Information System** (APHLIS) network. The system connects local experts in eastern and southern Africa and has recently expanded to West African countries. It dates back to the overall objective to develop an information system capable of generating figures for quantitative assessments of PHL of cereal grains. It makes data on the annual losses of cereals available to individual countries and regions. Among other sources it is taking the results of the "Missing Food" study into account.

The **Swiss Agency for Development and Cooperation** (SDC) has been focusing on

capitalising 20 years of Central American post-harvest experience (“Postcosecha”). Based on documented impact in Central America, SDC’s post-harvest priority now is sub-Saharan Africa. Implementing the message of WB’s and FAO’s recent “Missing Food” report, SDC is presently following a strategy of “highlighting what works”, intending to show that post-harvest losses can and should also be avoided in sub-Saharan Africa, through a scaling-up of the best existing technical solutions. The objective is to eventually make it possible to co-ordinate all interested actors in a

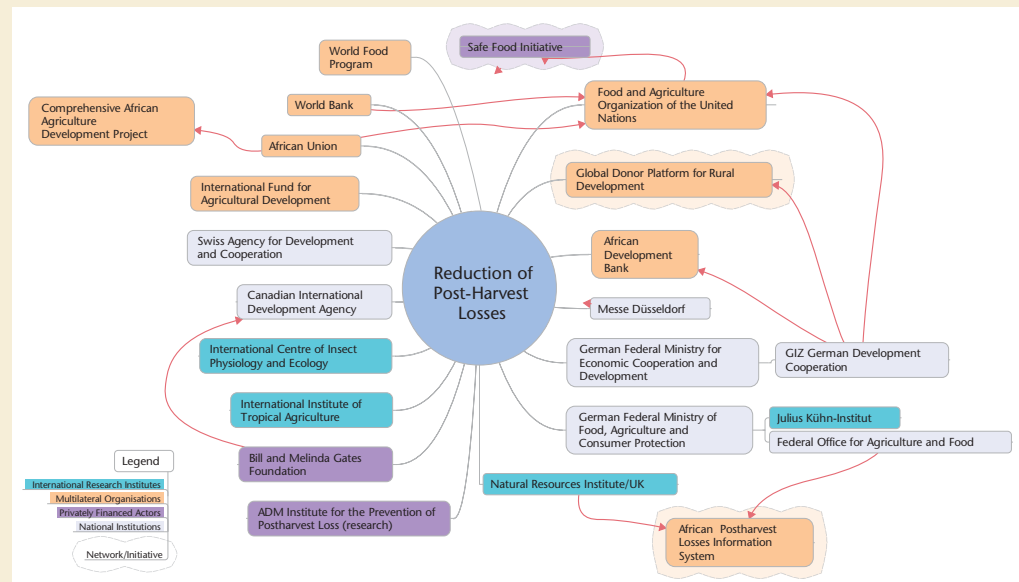
“Community of Practice” for organising knowledge sharing and the scaling-up of efforts for PHL reduction. SDC has started investing in several projects in sub-Saharan Africa, having so far earmarked 50 million Swiss francs for three programmes in more than ten countries for the next eight to ten years. The main partners so far are the International Maize and Wheat Improvement Center (CIMMYT), HELVETAS-Intercooperation, the FAO, the IFAD and the WFP.

■ Research activities

Both the public and private actors as well as the multilateral organisations depend on new input through research. Working in partnership with development agencies, the **Natural Resources Institute**, University of Greenwich, UK (NRI) contributes to pro-poor policy formulation and undertakes research and technical evaluations that underpin planning and investment decisions of its partners (see above: Missing Food study and APHLIS). NRI’s research focuses on food storage, food safety, food processing and the quality management of perishable produce. It sees itself as a leading authority in the field of root and tuber crops.

Among the research institutes, the **International Centre of Insect Physiology and Ecology** (ICIPE, Kenya) seeks to obtain

Some of the important actors and their actual cooperation from GIZ’s perspective



better evidence of PHL with data on which food is lost where, to help decision-makers and governments to optimise their policies and strategies for preventing losses.

The **International Institute of Tropical Agriculture** (IITA, Nigeria) does research for development and focuses on cowpea, soybean, banana/plantain, yam, cassava and maize crops. One example of its projects is the attempt to develop and evaluate strategies to reduce aflatoxin contamination of maize in Africa. The German **Julius Kühn-Institut** is currently examining storage and packaging improvement using nitrogen, carbon dioxide, high and low temperature treatment, plant substances as pesticides or attractants as well as the use of diatomaceous earth (Kieselgur) as a kind of natural pesticide (see also pages 26–29).

■ Private sector initiatives

Finally, to also introduce the private sector, one has to mention the recently founded **ADM Institute for the Prevention of Postharvest Loss**. It is a collaborative venture of the Archer Daniel Midlands (ADM) company and the University of Illinois at Urbana-Champaign intended as a response to concern over growing losses. The Institute’s vision is to “serve as an international information and technology hub for evaluating, creating and disseminating economically viable technologies,

practices and systems that reduce post-harvest loss in staple crops”.

Thanks to the volume of finance provided by the **Bill and Melinda Gates Foundation** (B&MGF), there are a diversity of projects on PHL. In co-operation with the World Food Logistics Organization the foundation seeks to improve knowledge on PHL in sub-Saharan Africa and South Asia. Furthermore, it has initialised the founding of the **Partnership for Aflatoxin Control in Africa** (PACA) that now serves as a basis to join efforts in this field of lost food. Last but not least, the private sector co-operation venture **Save Food Initiative** has been initiated by the FAO and **Messe Düsseldorf** (trade fair organisation). The four main goals are awareness raising, collaboration, policy, strategy and programme development. This initiative is therefore supporting private sector investment programmes in developing countries, has held connection meetings and has carried out two studies on food losses.

Please find the related links at www.rural21.com.

Julia Oberdörster, Heike Ostermann, Bruno Schuler, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Eschborn, Bonn, Germany

Post-harvest agriculture in a changing climate

Climate change will continue to exert its influence not only on crop production, but also on the increasingly valuable harvest. This article shares highlights from the author’s recent review of post-harvest agriculture in changing climates. It has a particular focus on durable cereal crops in the smallholder context of sub-Saharan Africa, revealing important insights into the bearing of post-harvest agriculture on global concerns such as food security.

Global warming is bringing complex and diverse climate change and impacts in sub-Saharan Africa (SSA; see Box on page 13). The economies of, and livelihoods in, many SSA countries are based on smallholder rain-fed agriculture. Whilst agricultural production in many higher-latitude countries is initially likely to benefit from moderate global warming, in tropical regions where crops are already close to critical environmental thresholds, crop yields and areas suitable for growing them will decline. Studies suggest that by 2080, countries such as Tanzania and Zimbabwe could lose up to 30 per cent of their 1990 cereal yields (Parry et al., 2004). Declining

yields are likely to trigger further agricultural expansion, deforestation, green house gas (GHG) emissions and subsequently global warming.

However, climatic change is just one stressor among many complex, interacting and dynamic factors that influence smallholder farming households in SSA. Other factors include: population growth, urbanisation, education, health, especially HIV and Aids, financial service provision and market changes. Vulnerability to climate change and adaptive capacity is determined by a similarly wide combination of interacting socio-ecological factors.

Post-harvest systems are influenced by the activities and interactions of many different players. An agricultural innovation systems perspective provides an analytical framework with which to examine technological and institutional change in post-harvest systems; identifying the players and factors affecting demand for, and use of, existing and new post-harvest and climate change knowledge.

■ Food security and post-harvest agriculture

Most cereals consumed in SSA are produced by smallholders, with commercial imports accounting for roughly 25 per cent of the cereal consumption in the region and food aid for about 5 per cent. However, post-harvest losses of cereal grains in SSA are estimated to reach nearly four billion US dollars annually, which in cash terms, equates

Tanya Stathers, Richard Lamboll
Natural Resources Institute (NRI)
University of Greenwich, United Kingdom
TStathers@aol.com

Brighton M. Mvumi
University of Zimbabwe

■ Post-harvest systems

Post-harvest systems are diverse, reflecting the varied nature of the people, place, focal crop or product and the different activity stages involved.



Post-harvest activity stages: Winnowing grain / drying grain / storing grain in indoor woven granary or sacks / outdoor raised grain store.

Photos: T. Stathers

Anticipated climatic changes in sub-Saharan Africa (SSA)

Projections suggest that by the year 2030, temperatures across SSA will have risen by about 1 °C compared to those of 1980–1999 (Lobell et al., 2008). Additionally, southern Africa is likely to experience a 10 per cent rainfall decrease and more frequent drought, while East Africa is expected to see rainfall increases in the north and decreases in the south. Increasing occurrences of high rainfall events and flooding are also anticipated (Christensen et al., 2007).

to wasting 15 per cent of SSA's annual cereal production (World Bank et al., 2011). As yields are expected to decline and the value of harvested and traded commodities subsequently increases, the cost of not reducing these post-harvest losses also increases. Furthermore, in this scenario, where extra food has to be produced to compensate for losses due to ineffective post-harvest management, this is a waste of valuable resources. With Africa's population projected to double to two billion people by 2050, and living standards and populations elsewhere also increasing, estimates suggest that global food production will need to increase by 70 per cent. Under a scenario of continuing high population growth and regional disparities in income, an additional 550 million people globally could be at risk of climate-related hunger by 2080, with 65 per cent of this increase occurring in Africa (Parry et al., 2009). There are key post-harvest elements of food availability, stability, access and utilisation. For example, maintaining high quality and sufficient stocks of stored grain enables a household (or a nation) to provide itself with a nutritional and safe supply of food until the next harvest. Given that the market value of grain typically increases up until the next harvest, grain stocks also provide a market-linked asset, part of which can be sold if needed to cover income shocks or emergencies.

■ Post-harvest impacts of climate change

Five key climate change trends affecting different parts of SSA were identified:

- a general increase in temperature;
- more frequent occurrence of dry spells and droughts;
- more frequent occurrence of high winds, storms, heavy precipitation events and flooding;
- more erratic rainfall;
- increased rainfall amount and/or duration.

These climate change trends are unlikely to occur in isolation from each other or other drivers of change.

The potential impacts of each of these climate change trends on the different post-harvest activities, assets (human, natural, physical, social and financial) and human well-being outcomes (food security, social, financial and economic) were identified. An example of this analysis for the potential impacts of a general increase in temperature on the drying, pest management and storage activity stages, and selected assets and well-being outcomes is given in the Table on page 14.

■ Post-harvest agricultural adaptation to climate change

Despite the significant uncertainty regarding the scale, type and interactions of climate change impacts, mitigation and adaptation activities are needed if we are to avoid the most serious consequences of global warming. After establishing the potential impacts, we identified a range of climate-smart post-harvest agricultural adaptation opportunities (see Box on the right).

Smallholder farming households across SSA are well aware of the impor-

tance of good food storage, and perceive their ability to store food as a strength influencing their capacity to adapt to climate change and variability. While the review highlighted just how many climate-smart post-harvest adaptation opportunities are already known and even practised by some farmers, it also illuminated the scale and problems faced in getting these 'no-regrets' post-harvest practices into wider social and economic use.

■ Factors influencing the adaptive capacity of post-harvest systems

The successful application of post-harvest technical solutions is depend-

Climate-smart post-harvest agricultural adaptation opportunities

- Growing and/or storing crops and varieties which are less susceptible to post-harvest pest attack;
- Prompt harvesting;
- Adequate and protected drying;
- Maintenance of the physical storage structures;
- Careful store cleaning and hygiene;
- Accurate estimation of food stock requirements;
- Protection and monitoring of grain to be stored for more than three months;
- Use of low GHG emission food preparation methods;
- Understanding and application of basic food safety principles;
- Increasing farmer access to market information and transport options;
- Use of early warning seasonal forecasts to project how the climatic conditions might impact on food storage or marketing strategies;
- Use of more water, energy and resource efficient processing, packaging and transport operations;
- Ensuring plant breeders evaluate post-harvest as well as pre-harvest crop characteristics; and
- Helping farmers to learn from others' and their own experiments.

Examples of possible effects of a general increase in temperature on selected aspects of post-harvest systems of durable crops in eastern and southern Africa

Impact on post-harvest activities	Impact on rural households' post-harvest assets	Impact on human well-being outcomes
<p>Harvesting and drying</p> <ul style="list-style-type: none"> Increased rate of crop drying, in field and at homestead Increased fire risk of the mature crop <p>Pest & disease management</p> <ul style="list-style-type: none"> Faster reproduction of insect pests and diseases (shorter lifecycles due to higher temperatures) leading to more rapid build-up of insects and fungi in stored produce Increased risk of fungal rot and mycotoxin contamination of stored products Pest and disease territories expand e.g. to higher altitudes or previously cooler areas Efficacy of some grain protectant active ingredients decrease and others increase <p>Storing</p> <ul style="list-style-type: none"> Higher pest incidence and carry-over during 'cold season' increases the need for thorough storage structure hygiene and management of residual infestation prior to storing new crop Increased pest reproduction and mobility leading to need to re-winnow, sort and re-treat grain midway through storage period Increased moisture migration and condensation resulting in rotting zones in grain bulks with excess free moisture Increased risk of reduced seed viability especially for some legumes, e.g. groundnuts 	<p>Human</p> <ul style="list-style-type: none"> Labour productivity reduced by: heat stress, reduced quality of diet and increased health risks due to more damaged produce, higher mycotoxin contamination and increased food prices Changes in post-harvest labour calendar due to faster crop drying <p>Natural</p> <ul style="list-style-type: none"> Crop varietal biodiversity loss if pests destroy stored grain/seed <p>Physical</p> <ul style="list-style-type: none"> Construction of traditional drying platforms and storage structures more difficult due to gradual loss of biore-sources <p>Social</p> <ul style="list-style-type: none"> Traditional food safety nets may not cope with the increased demands placed on them Greater fluctuations in seasonal grain prices may act as an incentive for traders to store more grain <p>Financial</p> <ul style="list-style-type: none"> Stored produce increases in value as prices become higher and more volatile, resulting in households attempting longer storage periods to ensure either greater profit or reduced expenditure on food 	<p>Food security</p> <ul style="list-style-type: none"> Reduced quality and quantity of food due to increased PH damage and loss [H, L, N] Increased dependency on non self-produced food [H, L] and imported food [N] <p>Social</p> <ul style="list-style-type: none"> Sale of productive assets (erosion of coping strategies) [H] Erosion of traditional social safety nets, as demands on them increase [L] Decreased investment in human capital (e.g. education, health and nutrition) [H, L, N, G] Reduced self-esteem, independence or human dignity associated with receiving food aid when there is food shortage [H, L, N] <p>Financial and economic</p> <ul style="list-style-type: none"> Soaring costs of food relief and safety net programmes [L, N, G] Resources withdrawn from long-term plans to meet short-term emergency needs, undermining economic growth and development [L, N, G] Rising food import bills [N] Re-orientation of public and private sector investments towards mitigating and adapting to climate change [N]

Key: PH=post-harvest, H=Household level; L=Local level; N=National level; G=Global level

ent on a well-functioning agricultural innovation system, which through experiential co-learning practice can overcome institutional constraints which are preventing the scaling out and up of post-harvest products and processes. However, across SSA, there is a desperate lack of skilled post-harvest service providers at all levels. As well as the post-harvest skills, understanding is needed of the futility of 'one-size-fits-all' solutions and the importance of responsive client-

focused services which support experiential learning processes to build the adaptive capacity of smallholder farmers to deal with increasingly uncertain futures. Post-harvest aspects are under-represented in most agricultural curricula. Peer learning is stifled by the very private nature of activities such as grain storage practices which usually occur behind closed doors. Additional knowledge gaps exist as regards understanding post-harvest gender roles. The lack of investment in post-harvest

compared to pre-harvest agricultural development, research and policy activities only accentuates the problems of getting post-harvest knowledge into use. Perhaps climate change impacts and shocks will gradually draw attention to the crucial role that post-harvest agricultural adaptation can play in strengthening livelihoods, attracting support and developing skills for getting the many 'no-regrets' climate-smart post-harvest adaptation opportunities into use at scale.

Nigeria: how losses in the maize and manioc value chains impact on the environment

In order to evaluate losses in the value chains of maize and cassava, GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) conducted two surveys in 2012/2013. They comprise (1) an estimate of losses in terms of volume and money and recommended countermeasures, and (2) a calculation of the ecological footprint resulting from these losses through the unnecessary use of soil and water, loss of biodiversity and emission of greenhouse gases.

■ Where are the biggest losses?

With its annual yield of around 40 million tons, Nigeria is the world's largest producer of **cassava**. The lion's share is grown by smallholders. The most important value-added chains are the production of Gari (fermented cassava) for local food supplies and the manufacture of industrial starch. Broken down in terms of the individual stages in the production processes, the losses are as follows:

- an up to 6.6 per cent loss of fresh cassava tubers in harvesting and storage at the farm;
- 8 per cent losses during on-farm processing of Gari, 14.4 per cent during commercial processing of Gari and 11.8 per cent during the production and storage of cassava starch. The relatively highest individual losses occur in the commercial manufacture of Gari, especially in sorting out tubers that were too small or too woody, and in the further transportation of Gari. An extrapolation across Nigerian cassava production as a whole revealed an annual loss of fresh cassava tubers at the farm and in further processing of more than 6.3 million tons, corresponding to around

37 kilograms per inhabitant. Across the entire value chain, the monetary losses amount to 686 million euro.

Maize is usually grown side by side with other crops by smallholders in Nigeria. In 2005, overall production was at around 10 million tons. The main value-added chains are the production of animal feed, making maize flour for human consumption and, to a small extent, using green maize for direct human consumption. Losses during harvesting were estimated as 4 per cent of the total harvest, while shelling, storage of dry maize cob and dry maize grain and transport of fresh maize to the market caused losses between 1.5 per cent and 2.3 per cent. Altogether, the losses on the farm were around 13.7 per cent. All in all, marketing is the process stage with the highest losses, accounting for up to 26 per cent. Lower but nevertheless still considerable losses occur in animal feed production (around 12 %). In total, the losses can be extrapolated to around 2.2 million tons of dried maize grains across the whole country, corresponding to a per capita loss of 13.5 kilograms. Total losses (including losses in the maize value-added chain) amount to roughly 576 million euro.

■ What does this mean for the environment?

The environmental impacts of post-harvest losses were calculated using the life-cycle analyses of the production of both cultures. As can be expected, land use for production emits the largest amount of greenhouse gases (GHGs), whereas transportation and processing have a much less significant effect. In addition to GHG emissions, water consumption, soil

use and the potential loss of biodiversity were assessed. The carbon footprint of cassava in Nigeria is relatively high (e.g. in comparison to Indonesia), which can be traced back to the low yields and hence to an ineffective use of natural resources such as soil and water. Since cassava and maize are grown in rainfed cultivation, water deprivation is relatively harmless, and at 18 cubic metres/ton, it is only conspicuously high in the processing of cassava starch. To illustrate the impacts involved, the water needlessly consumed owing to losses would be enough to cover the minimum water demand of 150,000 people, given that a person's basic needs require 50 litres a day according to UNESCO.

Losses in the cassava and maize value chains contribute 2.3 million tons of CO₂ equivalents to global climate change, which corresponds on average to the 4.5-fold per capita emission of a Nigerian or 3.3 per cent of total GHG emissions in Nigeria. Even if the data has to be interpreted with caution owing to a number of inconsistencies in the data base, this still indicates an enormous GHG potential of post-harvest losses. Moreover, the amount of maize and manioc losses corresponds to 21 per cent of the farmland that these crops are grown on.

The surveys clearly demonstrate that the environmental impacts of losses in the value-added chains are significant, also in relation to the natural resources of Nigeria as a whole. Thus, in addition to representing a positive contribution to world food supplies, a reduction of losses in the agricultural value chains could enhance Nigeria's efforts to combat climate change.

Heike Ostermann
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Eschborn, Germany



Photo: A. E. Ogunlade

Up to 6.6 per cent of fresh cassava tubers (l.) are lost in harvesting and storage at the farm; another 12 per cent is lost when making Gari (r.).



Photo: A. E. Ogunlade

Tackling post-harvest cereal losses in sub-Saharan Africa

Post-harvest loss reduction raises food availability without increasing the use of land, water and agricultural inputs. This article refers to the case of grain to show the hurdles that farmers have to clear in taking measures to reduce losses and suggests ways that post-harvest practitioners can target mitigating actions in sub-Saharan Africa.

Cereal grains are the main food staples of sub-Saharan Africa (SSA). Losses after harvest of both quantity (weight losses) and quality deprive farmers of the full benefits of their labours. Weight losses typically range from 5 per cent to 40 per cent of production (see Figure), averaging about 13.5 per cent. It has been suggested that for eastern and southern Africa the value of this weight loss amounts to about 1.6 billion US dollars (USD) per annum, or possibly about four billion USD for all of sub-Saharan Africa. This exceeds the value of total food aid received by SSA in the decade 1998–2008, equates to the value of cereal import to SSA in the

period 2000–2007, and is equivalent to the annual calorific requirement of at least 48 million people (World Bank, 2011).

Post-harvest grain losses result from both the scattering of grain due to poor post-harvest handling (harvesting, threshing, transport) and from biodeterioration brought about by pest organisms that include insects, moulds and fungi, rodents and, sometimes, birds.

The effects of biodeterioration are made worse by mechanical damage during handling as broken grain is



Photo: R. Hodges

much more susceptible to other types of quality decline such as pest attack. Furthermore, inadequate storage protection allows the entry of water and facilitates easy access by insects and rodents, while in large-scale bag storage chemical browning reactions may lead to grain discoloration called ‘stack-burn’.

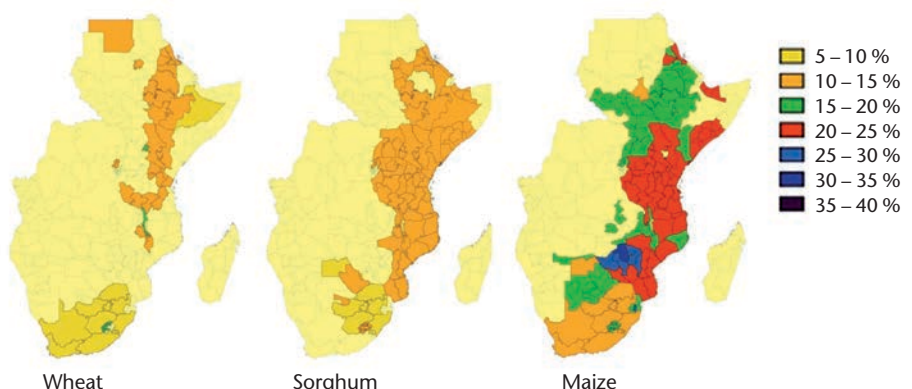
Grain weight loss is easily understood as a loss of food; on the other

Rick Hodges and Ben Bennett
 Food and Markets Department
 Natural Resources Institute
 University of Greenwich, United Kingdom
 R.J.Hodges@gre.ac.uk

Marc Bernard
 Federal Office for Agriculture and Food
 Bonn, Germany
 mbe@zadi.de

Felix Rembold
 Joint Research Centre of the
 European Commission
 Ispra, Italy
 felix.rembold@jrc.ec.europa.eu

Estimated cumulative per cent post-harvest weight loss from production of various grains in eastern and southern Africa for 2007



Source: African Post-harvest Losses Information System

hand, quality loss is a more complex phenomenon and is usually expressed in financial terms. Reduction in quality confines grain to lower value markets, which are usually informal, so that farmers lose the opportunity of better incomes. When both types of loss are expressed in cash terms, quality losses may often be greater than weight losses. Furthermore, quality loss may also include a decline in nutritional value, and when grain drying during handling is inadequate, then subsequent mould growth can lead to the production of toxins, e.g. aflatoxins. These may seriously damage the health of consumers (see also pages 30–31).

■ It won't work without incentives

Central to any effort to reduce losses is the adoption of better post-harvest practice. This includes improving the application of existing approaches to post-harvest handling (e.g. ensuring basic hygiene), introducing new technologies (better grain driers, shellers, stores, etc.), and adopting new marketing arrangements such as collective marketing, or new financial institutions. The latter include inventory credit or warehouse receipts systems that can give access to the credit needed to enable farmers to adopt better practices and technology.

When thinking about loss reduction, it is useful to distinguish between farmers who are net-deficit grain producers and those who are surplus producers. Most deficit producers lack commercial opportunities and may need direct subsidy before they can adopt improved post-harvest methods to reduce losses and improve their food security. In contrast, surplus producers have the potential to invest in better post-harvest technology if they can gain sufficient income from their grain production, consequently such farmers can benefit from improved marketing

arrangements and access to credit. For surplus producers, the process leading to adoption of better technology requires preconditions such as a market that offers sufficient reward for better quality grain, transport infrastructure giving reliable linkage to a market, and the knowledge and skills to produce good quality grain in a commercial context. Farmers often find that it is not worthwhile investing in the production of good-quality grain because the financial rewards are insufficient. Such an investment is not necessarily confined to the costs of better technology but also requires a change in farmers' priorities and in the risks that they are prepared to take, and may be set in a relatively complex scenario (see Box). Critically, a suitable incentive is needed to encourage post-harvest loss reduction.

■ Why a value-chain approach is necessary

It is not only these surplus-producing farmers who would benefit from the production of good-quality grain. Others working in the grain trade, the traders, transporters etc., also benefit because a successful, quality-conscious grain trade offers much increased grain flows in national and regional markets, leading to better business and better nutrition for all. It is common for traders to purchase poor quality grain from farmers at a discount and then to recondition this grain so that it conforms to grade requirements. But this process of reconditioning involves substantial grain losses and costs. The result is less grain on the market and higher priced grain. Alternatively, farmers could produce good-quality grain

Complex arrangements behind loss reduction

A real-life example demonstrating the complexity of circumstances is the case of the Iganga Farmers' Group in Uganda. Previously, they could not shell their maize cobs soon after harvest as they had more important tasks, including land preparation for the next harvest. When there was time, they shelled their maize by beating the cobs with sticks, a long and tedious process resulting in plenty of broken grain. They then lacked time to sort the grain to meet the quality requirements of a local warehouse receipts system. But a new opportunity appeared when a motorised thresher was offered for hire. Using this machine, they could shell their maize quickly and directly after harvest, giving a number of important advantages. As the machine was more efficient than hand-shelling, there were fewer broken grains; with less delay, quality decline was minimised, and now they had time to sort their grain to ensure good quality. In this new scenario, they moved their maize very quickly to the warehouse and received a warehouse receipt. With the receipt, they borrowed money from the bank to finance the inputs required for planting the next crop. At the warehouse, the Manager noted that the grain from this Group was now of much better quality, so he didn't have to reject any and buyers of this warehouse receipt paid a premium price.

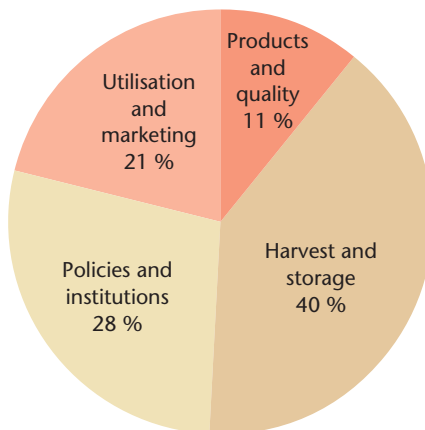


that does not need reconditioning. In that case, consumers benefit as they do not have to pay the costs of the losses inherent in this process and as the losses are lower there will be more grain on the market, resulting in prices rising less steeply. This highlights the need for a value-chain approach to help farmers sell better quality grain for higher prices. There is a need for more focus on market intermediaries, i.e. forward-looking local merchants, large-scale traders and farmer organisations (FOs), as channels to convey post-harvest extension messages and price premiums to farmers. The increasing importance of the value-chain approach was supported by a recent questionnaire survey of post-harvest experts, who were asked to recommend which future post-harvest developments are required to improve the quantity and quality of grain supply from smallholders. They targeted storage and harvesting issues but indicated the need for the support of better policies and institutions and improved marketing opportunities, including value addition (see Figure).

■ The need for a co-ordinated response to the problem

The international community currently has no clear means of co-ordinating development efforts in this area. Prior to the year 2000, the relevant body was GASGA (Group for Assistance on Systems Relating to Grain After

Recommendations for future interventions to improve the quality and quantity of grain supply in SSA, expressed in percent of suggested projects



Source: World Bank, 2011

Harvest), that subsequently became PhAction (The Global Post-harvest Forum), but this fell into abeyance as real agricultural commodity prices hit all-time lows and aid donors shifted their focus away from agriculture. In view of this void, the World Bank has recently called for the development of a new Community of Practice (CoP) on post-harvest loss reduction (World Bank, 2011). The opportunity is for a bottom-up, largely virtual forum where information and experiences can be shared, and good practice disseminated. The FAO (UN Food and Agriculture Organisation) are currently questioning stakeholders about their views on a CoP, and are suggesting that their INPhO (Information System

on Post-harvest Operations) may be a potential cornerstone.

Another body that may also be able to contribute to the CoP is APHLIS (African Postharvest Losses Information System – see Box). This is the initiative of the European Commission's Joint Research Centre and is a network of local experts in SSA who submit relevant data into the APHLIS database. The website displays estimated cumulative post-harvest weight losses of seven different cereal grains by country and by province; the results may be viewed as tables or as maps (see Figure on page 16). The intention is to provide data in support of agricultural policy formulation, identify opportunities to improve the efficiency of value chains and to enhance food security, especially through more accurate cereal supply calculations, and to provide a means to monitor and evaluate project performance. In the near future, APHLIS will facilitate its network members to develop their own country-specific web pages that provide narratives that elaborate on their post-harvest losses and offer web pages that give advice on aspects of post-harvest loss reduction.

Equally important is that the CoP provides access to project outputs, especially where these offer a guide through the complex technical, economic and social dimensions of loss reduction. A good example of this is the UN World Food Programme's 'Purchase for Progress' project that provides a quality conscious market for the cereals produced by farmers' groups in many developing countries. The groups are treated according to their state of development and provided with business and technical training; the latter has recently been supported by the development of a training manual that elaborates on all the major steps in the production of better quality grain.

➤ www.wfp.org/content/p4p-training-manual-improving-grain-post-harvest-handling-and-storage

African Postharvest Losses Information System (APHLIS): the features

- APHLIS losses tables can be 'clicked' to reveal a complete breakdown of the loss calculation, the sources of data, and an appraisal of data quality.
- APHLIS offers a downloadable version of the loss calculator as an Excel spreadsheet. Users can thus change default values within the calculator to those relevant to their situation and generate loss estimates for any geographical scale.
- APHLIS is easily upgraded as more reliable loss figures become available. Users contributing loss figures that are as good as, or better than, existing loss data will be added to the database.
- APHLIS may be updated annually, so that users can see trends across years. Website: <http://www.aphlis.net>

Better income through improved milk hygiene standards

Milk is crucial to the population of North Somalia, both as food and in creating income. But unhygienic transport and storage conditions are resulting in a loss of quality and hence losses in market value. A project implemented by Vétérinaires sans Frontières Germany seeks to improve hygiene management along the entire milk chain.

Eighty-two per cent of North Somalia's population depend on milk from mobile herds of camels, goats and cattle. Milk forms the basis of their diet and is a major source of animal protein and vitamins. Increasing urbanisation and sedentarisation provide ready markets for informal milk marketing, mostly organised along kinship lines and clearly dominated by female milk collectors and traders. In North Somalia, up to 48 per cent of the milk produced is sent to distant urban markets, about 19 per cent is sold directly in settlements within the production regions while at least 33 per cent is consumed by milk producing households. The milk trade provides income to pastoralist milk producers, milk collectors, milk transporters and urban milk traders. Milk producers receive about 54 per cent of the retail value of the milk, which reflects fair business relationships within the informal milk marketing chain. In the pastoralist economy, milk is worth nearly twice as much as meat.

Mario Younan
younan@vsfg.org

Abdirahim Gure
Friederike Schulze Hülshorst
fschulzehuelshorst@togev.de
Vétérinaires sans Frontières
Berlin, Germany

■ Poor hygienic milk quality

The milk is produced by mobile herds grazing in semi-arid areas without infrastructure or access to clean water. Raw milk for trade is transported on rough roads over long distances, in cheap recycled plastic containers without cooling and under high ambient temperatures.

While some milk is transported directly to urban markets by special milk collection vehicles, a large share relies on public transport ferrying passengers, livestock and other goods. Inadequate transport services plus poor milk handling result in contamination, rapid souring and, sometimes, spoilage of the milk before it reaches urban consumers. Female urban milk traders operate micro-businesses with an aver-



Photo: Vétérinaires sans Frontières

Metal milk cans improve hygiene during milk transport.

age daily milk turnover of between 25 and 35 litres. The vast majority of these traders have neither shops nor stalls and sell their milk directly on the roadside, under dusty and hot conditions. For all these reasons, most of the milk sold in urban markets is of very poor hygienic quality. However, the very high price of 1.33 US dollars (USD) per litre indicates the high demand. Imported milk (mostly milk powder, but also some UHT milk) fills the gap between demand and available local supply; most Somalis prefer locally produced milk. Retail prices are directly linked to milk freshness (see Table).

Urban milk retail prices (Puntland Region of Somalia, December 2012)

Milk Type	Price (US dollars per 750ml*)	Comment
Camel milk	1.25 USD	
Cow milk	1.50 USD	Very limited supply, niche market
Goat milk	1.25 USD	
Sour camel milk	1.00 USD	20 % profit loss compared to fresh milk
Very sour camel milk	0.75 USD	40 % profit loss compared to fresh milk, used for cooking
Sour goat milk	0.75 USD	40 % profit loss compared to fresh milk, used for cooking or processed into Ghee
Sour cow milk		Traditionally not sold, processed into Ghee

* Milk is traded in 750 ml volumes, called "Kombo"



Photo: Vétérinaires sans Frontières

Building a milk marketing hall in Galkayo substantially improved milk selling conditions.

As the Table shows, no milk losses exist in Somalia. Rather than throwing away bad milk, even low quality milk is sold as sour or very sour milk or processed into Ghee. It is the producers and traders who face income losses due to bad hygienic quality.

■ Camel milk has a clear advantage

In North Somalia, goats and cows lactate for only a few months a year, during and immediately after the rains. By comparison, camels lactate for 12 to 18 months, providing milk throughout the year. They are essential to the food security of pastoralist households. Certain antibacterial properties of camel milk give it superior quality compared to goat and cow milk, which enables it to be transported over longer distances than other types of milk. Furthermore, unlike goat and cow milk, camel milk can be sold whether fresh or sour, as Somali consumers value sour camel milk. Hence camel milk is the most widely traded milk in Somalia. During short periods of milk surplus excess goat and cow milk is traditionally processed into ghee, which sells at 12 to 15 USD/kg. Ghee from goat milk fetches slightly higher prices than cow milk ghee.

■ Improving the informal milk chain

Transport distances between milk producing regions and urban mar-

kets vary from 40 kilometres to more than 400 kilometres, with collection points located at 10 to 80 kilometres from milk production sites. Improved milk handling and milk hygiene during production, collection, transport and retail holds the potential to increase incomes of milk value chain actors and to provide safer milk to consumers. Improved milk quality also strengthens the market position of locally produced milk, which has to compete against rising sales of imported milk powder. In 2008, the EU-funded *Vétérinaires sans Frontières* Germany (VSF-Germany) 'Somali Pastoral Dairy Development Project' (SPDDP) established 25 Village Milk Collection Centres (VMCs) in North Somalia. VMCs were built at or close to existing collection points, from where vehicle transport to final markets begins. Metal milk cans were provided at an affordable cost to VMC users, who were also assisted in organising themselves in groups to manage the VMCs and operate their milk businesses. The money paid by the milk collectors and traders for the milk cans remained with the VMCs as start-up capital to help them expand their milk business. Organising milk collec-

tors is crucial to better relate them with transporters and urban milk traders. The primary role of VMCs is to provide milk collectors and traders with a facility for washing milk cans, which can then be sent back to milk producers or used for transporting milk to towns. VMCs are equipped with a water storage tank, a solar water heater and a washing room with taps, basins and drying racks. Milk collectors, transporters and traders were also trained on hygienic milk handling, milk transport and correct dispensing of milk at retail. Complementary trainings on animal husbandry and clean milk production are provided to milk producers so that they produce more and cleaner milk. Solar deep freezers for chilling milk cans in ice water baths to limit souring of milk during and after transportation are currently being provided to the VMCs and to urban milk trader groups.

Manual cream separators and trainings on their use enable milk producers to sustain their income through more efficient Ghee production in times of milk abundance. In one town, Galkayo, the EU-funded VSF-Germany 'Supporting Activities of Livestock Entrepreneurs in Somalia' (SALES) project built a milk marketing hall in 2010, substantially improving milk sales conditions.

An external review in 2012 estimated that the SPDD Project benefits 750 milk

Direct benefits to the local population

A milk retailer and VMC member

Mariam Mohamed Ali, 45-year-old female resident of Ainabo Town and mother of six children, is a member of the Ainabo Village Milk Collection Center (VMC). She also works as a milk retailer in her own small shop in town, where she sells both milk and other basic household provisions including food. Mariam sources her milk directly from the producers, who are the nomadic pastoralists, as well as being supplied by Ainabo VMC, who get the milk from the producers, too. On a single day, she buys 150 Kombos (1 Kombo = 750 ml) at a cost of 4,000 Somali shillings (SoSH) per Kombo, while she sells the same amount at SoSH 5,000 per Kombo.

From the income she earns in milk sales, Mariam meets her household's needs including food. She also saves a portion of that money and uses it to improve her current business (basically the two income sources of milk retailing and shop provision). Based on the above, Mariam's income from milk sale (less taxes) amounts to SoSH 750,000 a day (equivalent to 23 USD).

Vétérinaires sans Frontières Germany

Vétérinaires sans Frontières Germany (VSF-G) is an international non-governmental organisation which provides humanitarian aid and development assistance to pastoralists and vulnerable communities in areas where livestock is of importance. Support covers animal health, agriculture, marketing, food safety and developing peace and conflict resolution capacities of communities and governmental institutions. Thus food security and strengthened livelihoods of pastoralist communities are achieved. The Regional Office, based in Nairobi, co-ordinates the implementation of projects in Kenya, Somalia, Ethiopia, the Republic of Sudan and South Sudan. VSF-G was established in 1991 at the Veterinary University of Hanover, Germany, where the headquarters is still located. A new office was opened in Berlin in 2012.

collectors, transporters and traders supplying milk to between 50,000 and 100,000 consumers. These milk traders source their milk from up to 15,000 mobile milk producing pastoralist families, who indirectly also benefit from improved milk sales.

■ Problems and solutions

Although milk is traditionally a women's domain, it is men who control important assets in Somali society. This led to initial disputes over ownership and control of the Village Milk Collection Centres, which were overcome in all but three villages. As of December 2012, 22 of the 25 VMCs are active and controlled by the female milk collectors and traders.

The women do team up to collectively organise their milk transport and also share in dispatching their milk to markets according to short term supply and demand. But financially, each milk collector and milk trader operates her independent micro-business. It took time for VMC users to organise themselves into groups and to efficiently manage the milk collection centres. Management and financing of VMCs is especially crucial to ensuring regular water supply. Water has to be bought from tankers that truck it in from distant

Milk is women's business in Somalia. They collectively organise their milk transport and coordinate milk sales at the market.

sources. The women also collectively share cleaning and maintenance of the VMCs. After the initial seed capital from milk cans was exhausted, the better managed VMCs introduced a small handling fee (per milk volume) paid by each VMC user that fully covers the running costs of the VMC. But this is yet to become common practice in all VMCs.

Solar water heaters installed at the VMCs proved to be delicate and prone to breakages, necessitating some repairs. Also some water tanks were insufficiently sealed and had to be rehabilitated in order to stop leakages.

Initially, not enough milk cans had been given out compared to the daily volumes handled by individual milk traders. More cans are currently being supplied, the ultimate goal being to replace all unhygienic plastic containers

with metal milk cans. SPDDP is facilitating close co-operation between milk producers, milk collectors, milk transporters, milk traders and local authorities who oversee the urban markets to achieve this goal. This is being complemented by consumer awareness campaigns.

The project is also working on creating an enabling environment for the dairy sector by supporting the development of a dairy policy and mobilising local authorities to enforce standards in hygiene in the transportation and marketing of milk.

■ Unforeseen successes

In some settlements, the VMCs were the first permanent structures built in stone and concrete and some also became community centres. A number of VMC groups have successfully explored options to generate non-milk related income, including renting out rooms as accommodation for local travellers and to projects for meetings and for trainings. Several VMCs also became a temporary operating base for human medical vaccination teams. Some women groups are planning to use the solar freezers at the VMCs to produce and sell ice blocks to local shops and households.



Photo: Vétérinaires sans Frontières

Handling fresh vegetable produce from urban gardens

Up to 40 per cent of households in cities in developing countries grow vegetables in urban gardens for food and income. These valuable crops grown in small spaces contribute to the nutritional quality of diets; the surplus can be sold, providing income for poor families. However, great care has to be taken when harvesting and transporting these perishable crops to ensure that healthy, attractive and nutritious food reaches local markets and household tables.

Due to high levels of unemployment in cities, many families depend on growing their own produce, especially vegetables, on small plots for home consumption and for sale. Poorer families spend a larger proportion of their income on food. Thus the ability to grow their own vegetables contributes significantly to household food and income security. Nutrition security is enhanced as well; vegetables diversify diets and, more importantly, are a source of micronutrients, vitamins and minerals vital for good health (see Box on page 23).

AVRDC – The World Vegetable Center – develops and promotes a range of vegetables, from tropical tomatoes to traditional leafy crops, which can be grown in urban and peri-urban environments. Simple, low-cost methods to handle these valuable crops after the harvest can help urban and peri-urban vegetable growers reduce post-harvest losses and provide more and better quality vegetables at home and to local markets.

■ Post-harvest problems

Vegetable quality needs to be maintained from the moment of harvest. Even when the distance from the farm gate to the consumer is relatively short, as in urban and often in peri-urban horticulture, growers must take care when harvesting, storing, packing and transporting fresh produce to prevent damage and maintain quality. Harvested vegetables release heat from respiration and lose moisture, which detracts from their appearance and weight. A study conducted in Rwanda on amaranths packed for the market showed they had eleven per cent weight loss within half an hour, while in Benin, 89 per cent of the leafy greens that were packed for the wholesale market had mechanical damage (see: <http://ucce.ucdavis.edu/files/datastore/234-1848.pdf>). Leafy vegeta-

bles have a large surface area over which they lose a lot of moisture; even a five per cent loss will result in visible wilting. Not only do bruised, damaged, or over-mature vegetables appear unattractive and fetch lower prices on the market, they are also less nutritious. Poor handling and storage methods cause the nutrients in vegetables to deteriorate rapidly.

Water quality is another concern for vegetable production in urban settings. The source of water used to produce and clean the crop may be polluted by industrial and domestic waste. If pesticides are used on crops, pesticide residue may contaminate produce, and the local water supply, if producers are not adequately trained

Field trial in Shanhuan, Taiwan: a quality check for freshly harvested sweet pepper.

Jacqueline d'Arros Hughes
jackie.hughes@worldveg.org

Ngoni Nenguwo
ngoni.nenguwo@worldveg.org

AVRDC – The World Vegetable Center
Tainan, Taiwan / Arusha, Tanzania



Photo: AVRDC

and willing to follow proper use of the chemicals. Growers should avoid using polluted water to wash vegetables after harvest to prevent contamination from microorganisms, pesticide residues and heavy metals harmful to human health. Urban producers need a good understanding of the risks of using contaminated water. Simple solutions such as taking the produce to be cleaned at a site where the quality of water is not in doubt may be necessary.

■ Simple techniques, big effects

By following post-harvest handling methods best suited to their situations, urban and peri-urban vegetable growers can harvest and deliver produce of good quality to the point of sale. Technologies for resource-poor vegetable growers are available, and AVRDC continues to develop and improve recommendations for growers in urban, peri-urban and rural environments.

The first step to deliver a good-quality crop to the market is to harvest at the optimum stage of maturity. Leafy vegetables should be harvested when they reach full size and before they start losing color and becoming fibrous. Tomato is ready to harvest when its fruit is physiologically mature – that is, when the pink or red color first becomes noticeable on the fruit. Vegetables destined for the market should be graded to remove damaged or diseased material (which will also reduce spoilage) and packed into uniform lots so that they are attractive to consumers and fetch a higher price.

A simple way to reduce post-harvest losses is to harvest before temperatures are high, such as in the early morning or late afternoon, and to keep produce in the shade once it has been harvested. Leafy vegetables kept in the shade will maintain their quality longer than those exposed to full sun. Ice can reduce the temperature of harvested vegetables. Covering produce

Advantages of vegetable production in urban and peri-urban settings

Vegetables are particularly well-suited to urban and peri-urban farming because only a small land area is needed to produce an ample crop. For example, a home garden model developed by AVRDC – The World Vegetable Center – for a 6 m x 6 m plot can produce approximately 250 to 500 kilograms of fresh vegetables per year. Vegetables produced from AVRDC's home garden model can supply a family of four to six with 200 g of vegetables per person per day – the amount recommended by the World Health Organization for overall health and to decrease the risk of chronic diseases.

Many vegetable crops can be harvested within a short time from planting. Amaranths (*Amaranth spp.*) and water spinach or kangkong (*Ipomoea aquatica*) are ready to harvest in 30 days, and can be harvested up to ten times per crop cycle, providing a steady supply of fresh greens during the growing season. Vegetables such as amaranth, African nightshade (*Solanum aethiopicum*) or sweet potato (*Ipomoea batatas*) leaves are rich in nutrients, often surpassing more familiar crops such as cabbage in nutritional quality (see Table).

Vegetable production in urban and peri-urban settings means that the distance from the field to the consumer is much shorter. Home gardeners have fresh vegetables at their doorstep, and small-scale urban growers who sell their crops have the advantage of lower transportation costs. These growers may not have to deal with middlemen or brokers as rural farmers usually do, and thus are able to respond quickly to price fluctuations.

Nutritional value of selected vegetable crops

	Tomato (<i>Solanum lycopersicum</i>)	Cabbage (<i>Brassica oleracea</i>)	Moringa (<i>Moringa oleifera</i>)	Amaranth (<i>Amaranthus spp.</i>)	African nightshade (<i>Solanum aethiopicum</i>)	Sweet potato leaf (<i>Ipomoea batatas</i>)
β-carotene (mg)	0.40	0.00	15.28	9.23	4.84	6.82
Vitamin C (mg)	19	22	459	113	132	81
Vitamin E (mg)	1.16	0.05	25.25	3.44	2.08	4.69
Iron (mg)	0.54	0.30	10.09	5.54	3.89	1.88
Folates (µg)	5	ND	93	78	58	39
Antioxidant activity (Trolox* Equivalent)	323	496	2,858	394	683	870

Source: Yang & Keding 2009 (from: *African Indigenous Vegetables in Urban Agriculture*, edited by C.M. Shackleton, M.W. Pasquini, & A.W. Drescher: London).

*Trolox is Hoffman-LaRoche's trade name for 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid, a water-soluble derivative of vitamin E.

with a moist material, such as damp sacking or straw (taking care to keep the vegetables dry), is also effective in reducing the temperature by taking advantage of evaporative cooling principles.

Another simple technique is to use good-quality packaging that will protect the crop after harvest. Many growers put their newly harvested leafy greens in large polyethylene bags; during transport the leaves may be bruised or crushed. Bamboo baskets are not suitable for packing soft fruit vegetables such as tomato because the rough surface may damage the produce. Rigid containers

with smooth surfaces reduce crushing, bruising and damage.

Training urban growers in proper handling methods and disseminating information to show the economic benefits of good post-harvest handling can help ensure that more vegetables of better quality reach the market. Recommended techniques and technologies should not be time-consuming to apply or expensive, as the lack of capital is often a major barrier to adoption. Improved post-harvest handling results in a higher quality product which is more nutritious and should fetch a higher price – an important incentive for growers to adopt these techniques.

Technical know-how is only one side of the coin

In terms of figures, avoiding post-harvest losses could feed a third of India's poor. However, structural problems and shortcomings make this a difficult proposition.

Welthungerhilfe is seeking comprehensive solutions.

Agricultural produce undergoes a series of operations such as harvesting, threshing, winnowing, bagging, transportation, storage, processing and exchange before it reaches the consumer, and there are appreciable losses in crop output in all these stages. In the tribal, backward areas of West Bengal, Jharkhand, Orissa and Madhya Pradesh, where Welthungerhilfe is focusing its activities, losses are particularly high because the producers here are often unaware of the available best practices and mostly follow age-old traditional techniques learned from their forefathers that are frequently not the most efficient methods.

According to a World Bank study (1999), post-harvest losses of food grains in India account for 7–10 per

cent of the total production from farm to market level and 4–5 per cent at market and distribution levels. For the system as a whole, such losses have been worked out to be 11–15 million tons of food grains annually, including 3–4 million tons of wheat and 5–7 million tons of rice. Considering an average per capita consumption of about 15 kilograms of food grains per month, these losses would be enough to feed around 70–100 million people, i.e. approximately a third of India's poor. Post-harvest losses therefore have a significant impact at both the micro and macro levels of the economy. The graph on page 25 shows an estimate of post-harvest losses across various segments of food assessed by the Indian Council of Agricultural Research (ICAR). It demonstrates that post-harvest losses are more significant for fruits and vegetables because of their higher perishability.

■ A structural problem

The agricultural sector in India is highly fragmented when compared

to other countries. The average farmer works with just 2–4 acres, and 70 per cent of farmers have less than 2.5 acres (1 hectare). Agriculture and allied sectors contributed to only 14 per cent of Gross Domestic Product (GDP) in 2011–12; however, they employed more than 56.6 per cent of the population. Other supply chain actors including transportation companies, traders and whole-sellers are equally fragmented.

As a result, the large agricultural and logistics corporations had less earning opportunities in the respective period, whereas the existing players did not have the scale or capital to make necessary technology and infrastructure investments. The government has therefore been the major player in recent times, creating the infrastructure for storage, transportation, etc. However, the quality of such services has always remained a major concern, and vast areas of the country still do not have adequate facilities because of the unavailability of resources.

At the micro level, small farmers are struggling with their existing knowledge to find solutions to their day-to-day problems of harvesting, processing, storing and, in a very small number of cases, making value additions to the produce before selling it to the market. Here, middlemen grasp the opportunity, and often the rates are hijacked artificially and the producers in need of immediate cash or seeking to avoid rotting of their perishable products have to go for distress selling, losing out heavily on the profit margin.

Subhankar Chatterjee
Programme Manager
Welthungerhilfe Kolkata
Kolkata, India
subhankar.chatterjee@
welthungerhilfe.de



The photo on the left shows traditional methods of paddy threshing which are very labour-intensive and less efficient, whereas on the right, the villagers are using mechanical paddy threshers which are now available at the Common Facility Centers of the project villages.

Photos: S. Chatterjee/Welthungerhilfe

■ Government interventions

The Government had taken the initiative of establishing the Food Corporation of India (FCI) in 1965 with the purpose of i) effective price support operations for safeguarding the interests of the farmers, ii) distribution of food grains throughout the country via the Public Distribution System (PDS) and iii) maintaining a satisfactory level of operational and buffer stocks of food grains to ensure national food security. However, the existing infrastructures with FCI fall well short of current requirements. The media reports have exposed huge amounts of food rotting at the FCI godowns. An esteemed daily newspaper in India, the *Hindustan Times*, reported on July 27, 2010 that about 10,688 lakh (1,068 million tons) of food grains were found damaged in FCI depots, enough to feed over six hundred thousand people for over ten years. On the other hand, the Targeted PDS, which has the mandate to provide food grains to the vulnerable and marginalised poor, is suffering from a shortage of supply, and most of the consumers are complaining about corruption at the PDS outlets stopping them to receive food to meet their hunger. Once passed, the National Food Security Act may alleviate the problem as the government will have to distribute 62 tons of food grains annually, which will in turn reduce pressure on the FCI stores.

■ Capacity building at all levels

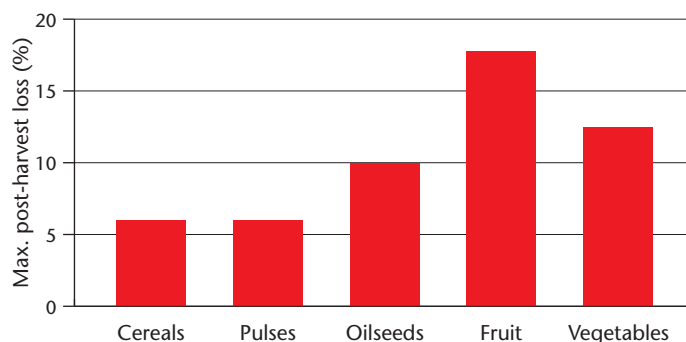
The Welthungerhilfe projects are targeting various points along the value chain. Under the project *Vocational education and training*, the rural youth from the most backward areas of West Bengal, Jharkhand and Orissa have been trained on sustainable harvesting and processing techniques, which has reduced their losses significantly. The training on *Food processing and value addition* has helped the farmers to process fruits and vegetables as different food items and sell them to the market.

Altogether, 450 farmers have been trained on sustainable agriculture practices (including post-harvest management), and another 50 farmers on food processing and value addition.

Under the *Market access project* in Jharkhand, with its partner Centre for World Solidarity, Welthungerhilfe worked on the entire value chain of paddy with more than 300 farmers following Systems of Rice Intensification techniques (see also Rural 21, 4/2012), which helped the small producers to almost double the traditional yield of 30 quintal/ha (1 quintal = 100 kg). The training also helped the farmers to realise the problems of the traditional practices of processing paddy and take a more scientific approach. Common Facility Centres extended mechanisation support to the marginalised farmers by introducing paddy threshers; local youths were encouraged to initiate mobile milling machines on tractors. As a result the farmers were able to properly mill their paddy to rice. Three women's self-help groups learned the processes of making puffed rice out of paddy and are now able to directly package and market it. The local value addition of rice is ensuring a better economic return of the produce.

After taking a training on *Spice grinding and processing*, the tribal rural women of Kashipur initiated a small turmeric processing plant very recently and started selling turmeric packets that they produced in their own fields. In the past, they would sell the produce to the middleman at a much cheaper rate. But now, after processing, they are able to receive a rate of around 120 rupees (INR) per kilogram, compared to the earlier rate of INR 80/kg.

Estimated post-harvest losses in India



Business Standard, 2010, ICAR study

■ Giving communities a stronger voice

Currently, the communities are very enthusiastic about post-harvest processing and value addition to reduce losses and increase income. The smaller farmers have been collectivised into farmer clubs, self-help groups enabling them to participate in learning, share their experiences and collectively process and market their produce to reduce loss. The villagers are also taking collective efforts to market the fresh vegetables directly by negotiating with the traders on collective terms to guarantee timely procurement and better rates. The involvement of the self-help groups also ensures women's participation and sharing of responsibilities. Welthungerhilfe, under the Fight Hunger First Initiative, is also advocating for a better and more accountable PDS, whereas the communities in Jharkhand, West Bengal, Orissa and Madhyapradesh are addressing Community Monitoring of Public Services with tools such as Social Audit, Community Score Card etc.

The biggest challenge in India is to attain fairer and more transparent public distribution that can really reach the poor in time. Therefore, alongside imparting technical know-how on post-harvest management and setting up primary infrastructure for storage and distribution, the communities have to claim their right to food and put pressure on the PDS to improve its services.

New developments in stored product protection

Preventive methods are the most effective tools to protect stored products. This article shows under what conditions and how stored products are infested and what is new in research and development.

Any plant or agricultural product we produce for human consumption or animal feed will sooner or later be stored in a more or less processed state to be consumed or further processed to a final product. Depending on the water content, we can distinguish perishable products such as fruits or vegetables with a higher moisture content from durables such as grains, pulses, nuts, dried fruits or dried herbs and spices with a low moisture content. Often, the protection of perishables is summarised as post-harvest protection, while the protection of durables is called stored product protection. Usually, products of a higher water content are attacked by fungi and bacteria through a damaged cuticle, such as a cracked tomato skin. Infested plants, stems, roots or fruits should be separated and discarded before the microbial infestation spreads to other products. Perishables may also just lose water and start to shrivel up, or they may start to sprout, as in the case of potatoes.

■ What are stored product pests?

In durable products, the main pests are **insects**. These are some 100 species of beetles, moths and dustlice that have become specialised to survive in a com-

paratively dry environment. Usually, the moisture content in the product is sufficient for stored product insect survival and reproduction. Additional water is produced chemically by respiration, thus breaking down carbohydrates by producing water, energy and carbon dioxide. This is the main reason why heavily infested goods tend to become moist and hot. The Figure on page 27 shows that within a month, 20 granary weevils in 200 grams of triticale can increase the moisture content to levels where microbial development commences and leads to a rapid deterioration of grain.

Only in extremely arid climates (relative humidity < 35 %) may grain kernels become so hard (e.g. wheat moisture content < 9 %) that not even stored product insects can attack. The latter are also adapted to detect suitable food and oviposition sites by smell, a point

that will be discussed later. Even water or spots with increased moisture can be detected by insects.

Vertebrates such as rodents or birds may also feed on stored products. But it is easier to keep these pests away by a good structural design of the storage building because they are much larger and usually need an additional source of water.

Microbial deterioration of durables usually occurs if the product was not sufficiently protected from rain or moisture or after an attack by insects, mites or vertebrates that increased the moisture content. Mites already require higher moisture contents and often occur together with storage fungi. Because

Durable stored products: beans and grains.



Photo: C. Adler

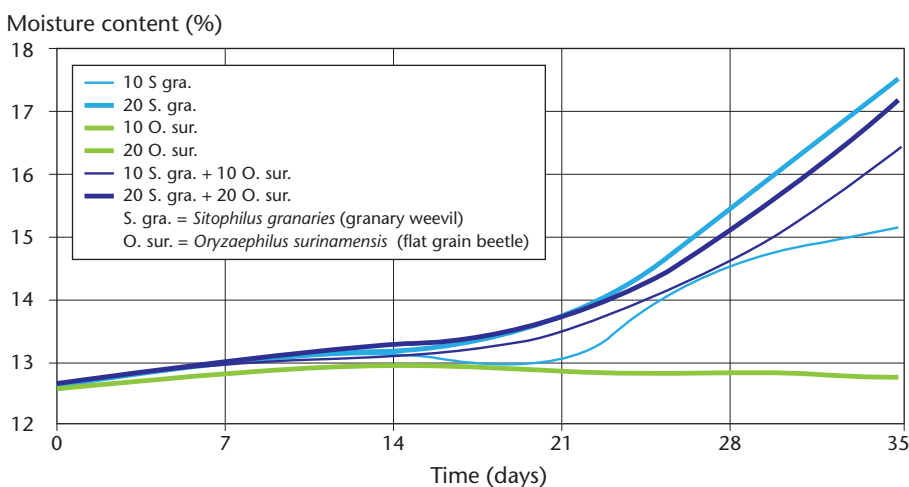
Cornel Adler
 Julius Kühn-Institut
 Federal Research Centre
 for Cultivated Plants
 Berlin, Germany
 cornel.adler@jki.bund.de

many stored product fungi such as the genera *Aspergillus* and *Penicillium* are known to produce mycotoxins, a visible microbial infestation generally renders the stored product unsuitable for human or animal consumption. Mycotoxins are the most toxic chemicals known in nature. They are stable to heat and cannot be broken down by cooking or baking. In many tropical and subtropical countries higher incidents of liver cancer and kidney failures can directly be linked to increased human uptake of mycotoxins through infested food, mycotoxin-contaminated meat or beer.

■ What happens during an attack?

Often, an attack starts with a few individuals or one gravid female arriving at a suitable infestation site. Given suitable stored products and moisture contents as well as temperatures above some 15°C, oviposition will occur. One can distinguish primary pests (e.g. the lesser grain borer *Rhyzopertha dominica* or weevils of the genus *Sitophilus*) that can attack a healthy product such as a complete grain kernel from secondary pests that require broken kernels or damage caused by a primary pest (e.g. the flat grain beetle *Oryzaephilus surinamensis*). The insects break down carbohydrates and produce carbon dioxide, water and energy by respiration. Predators and parasitoids may multiply as soon as they find sufficient numbers of hosts and add to the metabolic production of moisture and heat. Mites and dustlice can multiply in products with increased water content and further accelerate the formation of hot spots with increased temperatures. Frass, faeces and the webbings of moth larvae reduce grain convection and keep moisture and heat in the vicinity. Microbial deterioration starts with xerophilic (draught-tolerant) fungi that also require respiration for metabolism. Only at water activity levels close to 1 and corresponding grain moisture contents above 18 per

Changes of moisture content (%) in 200 g triticale from Belarus after infestation with given numbers of adult grain pest beetles at 20°C



cent will yeasts grow without the need of oxygen. Gases produced by microbials can form flammable mixtures and ignite spontaneously. But even if no fire occurs, mycotoxins produced in heavily infested grain render the formerly valuable stored product a toxic waste.

■ Where do the pests come from?

If a pest is found in a package, a storage site or a food factory, it may either have been introduced together with the raw product, it may have been present as part of a residual infestation in machinery or hiding spaces in the building or it may have entered through openings being attracted from outside. This stresses the importance of inspecting the raw product prior to storage, checking the storage structure for a residual infestation (e.g. by heat treatment) and maintaining an insect-proof structural design. To stop the immigration of most beetles, the largest opening in window frames, wire mesh gauzes, package perforations or seals should be not more than 0.5 mm. To prevent neonate larvae of stored product moths, these openings must not be larger than 0.1 mm (Kahn 1982, Adler 2004). Of course, this is quite a challenge and one of the reasons why insects find their way into stored goods so often.

■ What are reasons for major losses?

In general, a farmer harvesting an agricultural product will try to avoid losses once the harvest is stored. However, certain factors may favour pest attack and losses. For many years the value of grain was extremely low. This is why no one in Central Europe invested in the construction of good grain storage structures for decades. And if grain storage space was desperately needed business assessments dictated the cheapest corrugated metal silo available. This type of silo is common in most parts of the world even though it does not prevent condensation and subsequent moulds or the immigration of insects and is not easily cleaned because of grains getting stuck between metal sheets and not easily sealed for fumigation. But with good weather conditions and sufficient wind, storage in corrugated metal silos may still cause few problems. Only if hot and moist weather conditions occur together with high numbers of flying grain pest insects could major losses occur. Locally, these losses may be higher if a given grain storage remains largely unattended. In Europe, most larger grain storages have thermometer cables to survey the development of a hot spot caused by insect respiration and mould development. Studies are under way to find out if acoustic or optic devices could provide



Photo: C. Adler

*Pressing oil from neem seeds dried under different conditions. The seed cake extruded in front also has insecticidal properties and was used in the field to repel the potato beetle *Leptinotarsa decemlineata*.*

an even better early warning measure at feasible costs.

■ What is integrated stored product protection?

One can distinguish between preventive methods, monitoring methods to detect pest organisms and control methods (see Figure on page 29). Taking into account that product quality always suffers from an attack, all techniques to render a given storage unsuitable for stored product pests should be evaluated. Cool climates, strong or dry winds or the prevalence of aromatic plants may deter stored product insects from a certain area, and knowledge about insect occurrence may help find a suitable site for a new storage.

An insect-proof or hermetic (gas-tight) structural design may be one way to prevent stored product pests from establishing in uninfested goods. This aspect will be discussed later. But keeping dry products such as tubers under a layer of dry sand in earthen pits may be another way to prevent insects.

■ What is new in stored product protection?

Hermetic storage and packaging. New storage methods provide farm-

ers with hermetic enclosures, such as gas-tight multilayer bags or silobags. A new research project in Germany is to find out if long-term grain storages can be rendered gas-tight at feasible costs and the effect this may have on grain quality at various moisture contents. Since the European ban on dichlorvos (an organophosphorous insecticide) evaporation strips in 2007, conventional grain storages have been facing problems with stored product moths flying into grain storages during warm summer months. This prompts repeated fogging treatments or fumigation in a storage of up to one year but poses a much greater problem to long-term storages. The project is also testing vacuum packaging and low oxygen storage of grain.

Heat treatments for empty structures. Heat treatments with temperatures above some 50°C are used to disinfect empty structures such as silo bins, flour mills, or bakeries in Germany. Usually, some five hours at temperatures above 50°C proved sufficient to control all stages of test insects in heat-treated structures. Metal machine parts or silo bins are usually good conductors of heat. Natural stones and wood show less thermal conductivity, and most energy is required to heat massive concrete structures. However, insects need to be directly exposed to heat, insulators such as grain or flour, dust or packaging material provide good protection and may allow insect survival.

In hot and dry climates, black metal sheets or empty jute sacks could be used for solar heating of air, and with some ventilation this air could be directed into structures or jute sacks, achieving disinfection at low costs. At temperatures above 60°C, a few seconds are sufficient

for complete control. Laboratory experiments were carried out at 45°C, 50°C and 55°C, because at 60°C, the shortest exposure times tested (15 min with *Lasioderma serricorne* in 10ml of wheat bran) already gave complete control of all stages.

Hot air may also be used to dry grains or control an insect infestation if care is taken not to overheat living seed germs. Otherwise, heat stress may cause levels of germination to drop, indicating other losses in grain quality.

Plant extracts to repel and control pests. In many parts of the world, certain branches, fruits or seeds are traditionally put in between harvested products to repel pests. Numerous scientific studies have been carried out to determine the insecticidal potential of herbs, spices, medical plants and the pure compounds found within these plants. In our lab, we have studied plant extracts since around 1984. Since the early 1990s, we have only supported project applications involving identified and quantified pure compounds. Otherwise, the plant used would be like a black box. An overkill of factors involved in the production and presence of active ingredients such as plant species, soil quality, irrigation, field pest pressure or storage conditions after harvest would render information on efficacy useless.

The pure compounds with pronounced insecticidal properties included anethole, 4-allyl-anisol, camphor, 1,8-cineol, and eugenol, cinnamaldehyde and azadirachtin. Neem oil contains the main active ingredient azadirachtin and has the advantage of being available to farmers in many tropical countries. Our PhD student Katamssadan H. Tofel from Cameroon is studying the effects of various preparation methods on azadirachtin contents and insecticidal efficacy of a self-made product (see photo above). Of course it is important to consider that repellent or insecticidal compounds may also change the taste or smell of a treated

stored product and even be hazardous to the consumer. This is why workers safety and consumer protection aspects must be taken into account when essential oils or insecticidal compounds are purified or used at concentrations higher than naturally available.

Plant extracts to attract pests into traps. One of the astonishing capabilities of stored product insects is their capacity to detect suitable products via olfactory cues. The Indian meal moth *Plodia interpunctella* was observed placing its eggs directly onto the perforation of a box containing animal feed. Our PhD student Agnès Flore Ndomo from Cameroon is identifying pure compounds from various fruits and nuts that the moth responds to. While moth traps at present use the lure of sexual pheromones which only attract males, food lures, which would also attract females, could be used for mass trapping and pest control.

Diatomaceous earths for pest control. Diatoms are mono-cellular planctonic freshwater and saltwater organisms occurring in huge numbers. They use silica (SiO₂) to form intricate skeleton structures. These silicates are amorphous and not crystalline, which is an important factor in workers' safety. Diatomaceous earth (DE) can be used to filter beer or juices, as inert material in pharmacy to produce pills or in toothpaste, as an abrasive agent on our teeth. Silicate stone layers formed by myriads of diatom skeletons can be found

in most regions of the world. These stones can be milled to dust and sieved to a desired particle size. Insects coming into contact with these dusts pick up fine particles on their cuticle, where the dust binds to the wax at the epicuticle and increases the surface, leading to a continuous loss of water. Joints of mouthparts, legs, antennae, and sexual organs are clogged. Desiccation causes insects living in critically dry conditions, like most stored product insects, to succumb within hours up to a few days.

In a project with partners from south-eastern Europe, we found that insecticidal efficacy varies among different proveniences of DE (Athanassiou et al. 2011). Lipophilic DE and small particle sizes were found most effective. Efficacy is much higher at high temperatures, when insects tend to move around faster and desiccate faster. This is why DE research is now also carried out in co-operation with colleagues from Ngaoundere University in Cameroon.

■ Conclusions

Stored product insects compete with humans when durable goods are to be stored for longer periods. Preventive methods such as insect-proof packaging or hermetic storage structures, cool storage or dry storage conditions together with careful inspection are the most important tools for safe storage. Pest insects should be detected as soon as possible by traps, inspection, tempera-

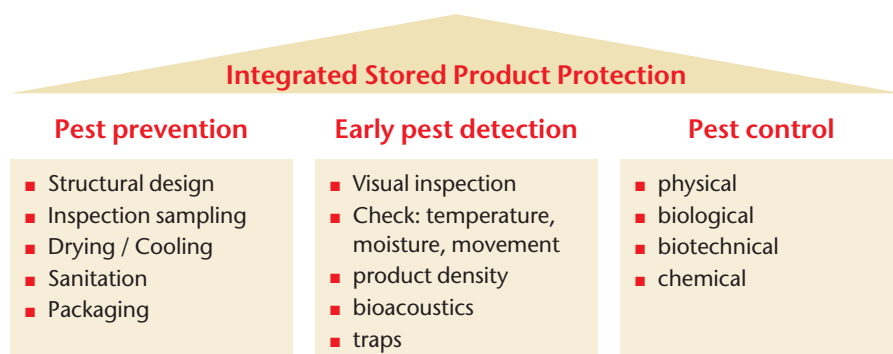
A case for co-operation

From farmers to consumers, everyone suffers from stored product pests. Stored products are important goods for international trade, and the insect pests travel with them. Today, most stored product insects are true cosmopolitans. Here, co-operation makes sense. We can learn from different solutions found in different places. Traditional knowledge may be confirmed by modern science and even improved to help reduce losses. Research can be expensive, and co-operation may help avoid duplication. If co-operation promotes results being published and known to a broader public, this can help reduce losses and even hunger.

ture surveillance or acoustic methods. Depending on the product and techniques available, physical, biological, biotechnical or chemical means may be used for pest control. Less hazardous methods of control have gained importance lately. Fumigants and physical control techniques have replaced contact insecticides, and low-oxygen controlled atmospheres are substitutes for some toxic fumigants. As stored products, climates, storage types and available techniques vary, the most suitable methods need to be identified for each situation. However, within the last ten years, we have lost many researchers. The Australian Stored Grain Research Laboratory (SGRL) was closed, and the UK's Food and Environment Research Agency (FERA) group on Stored Products is no longer active internationally, the colleagues of Agriculture Canada are just facing serious cutbacks, and the last stored product protection researcher of the French Institut National de la Recherche Agronomique (INRA) retires in 2013. Looking at the dwindling numbers of researchers attending international conferences addressing stored product protection, we urgently need young colleagues to carry on the quite rewarding research in stored product protection.

Cited literature can be provided by the author.

The three columns of integrated stored product protection*



*Modified from Adler 1998

No chance for aflatoxins

Food contaminated by aflatoxins is one of the most serious consequences that poor post-harvest management can have. In May 2004, for example, numerous fatalities were recorded in Kenya that could be traced back to the consumption of maize poisoned by the fungus. The Aflacontrol project sought to provide empirical evidence of the cost-effectiveness of aflatoxin risk-reduction strategies along maize and groundnut value chains in Africa and to understand what prevents adoption of these control strategies.

During the Aflacontrol project (see Box), run between 2009 and 2011, maize samples were collected each month before harvesting, in storage (15- to 30-day intervals) and in the markets from Kenya's Upper Eastern (Embu/Mbeere), Lower Eastern (Makueni, Machakos) and South Western (Kisii/Rongo/Homa Bay) regions, and aflatoxin prevalence levels were analysed. In the course of the analysis, Mahuku et al. (2011) found that aflatoxin prevalence in Kenya was much more widespread and also higher than expected. While Eastern Kenya is where the highly publicised deaths associated with aflatoxin occurred in 2004, sampling in the different agro-ecological zones also found aflatoxin levels in farmers' fields that were above the legally allowed 10 parts per billion (ppb) in the Western parts of Kenya. And the proportion of maize with aflatoxin levels greater than 10 ppb was higher in farmers' stores and markets, suggesting that current maize drying and storage practices are inadequate in minimising exposure to aflatoxins.

Groundnut samples were also collected at the same intervals from the Kayes, Kita, and Kolokani regions of

Mali and aflatoxin prevalence levels analysed. In the course of the analysis, Waliyar et al. (2011) found levels greater than 20 ppb in over 33 per cent of the fields across the study regions. Moreover, like in Kenya, aflatoxin levels increased in storage and in the markets, indicating, as with maize, the inadequacy of current groundnut drying and storage practices.

Socio-economic surveys were implemented in households and communities and with traders from the same regions, providing baseline information on the role of maize in households' livelihoods and people's knowledge, attitudes, and perceptions surrounding aflatoxin. The surveys also revealed how knowledge, attitude, and practice indices influenced household practices and their willingness to pay for technologies that could reduce aflatoxin prevalence as well as consumers' willingness to pay a premium price for maize or groundnut certified clean from aflatoxins.

In Kenya, about half those surveyed reported taking maize home to dry on tarpaulins. Around 30 per cent left

maize uncovered in the fields. Only few used storage structures. In Mali, nearly half of those surveyed dried groundnuts in large piles in the field. As in Kenya, few Malian farmers used storage structures. Among those that did, traditional granaries were most popular.

■ Few storage structures, poor knowledge

Basic knowledge of aflatoxin was extremely low in both countries (Narrod et al., 2011). In Kenya, households in the drylands, where aflatoxicosis outbreaks occurred in 2004, had a higher perception of risk, as expected, but low knowledge on safety attributes and the necessary measures to minimise exposure to aflatoxin. These observations suggest that a lack of understanding of the problem contributes to poor control of aflatoxin in the region. The survey also showed that most farmers who had heard of aflatoxin obtained that information via local language radio and extension workers. Research findings indicate that being involved in selling maize has no effect in terms of action

Clare Narrod and team*
Joint Institute for Food Safety and Applied Nutrition (JIFSAN)
University of Maryland
Maryland, USA
cnarrod@umd.edu

*see rural21.com

The Aflacontrol project

The Aflacontrol project was a multi-disciplinary, multi-institute effort facilitated by the International Food Policy Research Institute (IFPRI) and involved scientists at the International Maize and Wheat Improvement Center (CIMMYT), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), L'Institut d'Économie Rurale (IER – Mali), the Kenya Agricultural Research Institute (KARI – Kenya), ACDI/VOCA (Kenya), the University of Pittsburgh, and Uniformed Services University for the Health Sciences. A full summary of the project and its activities is available at <http://programs.ifpri.org/afla/afla.asp>.

to reduce aflatoxin risk in Kenya. For Mali, those households that were more market-oriented (i.e. sold more than 25 % of produce) were more likely to take action to ensure better crops and use storage facilities to mitigate risk.

The survey work also looked into the influence of behavioural factors on individual adoption of strategies to reduce aflatoxin risk. Tiongco et al. (2011) conclude that in both Kenya and Mali, producers with more assets were hypothetically more willing to pay for aflatoxin risk-reducing technologies. And in Kenya's drylands, where outbreaks of aflatoxicosis had occurred, respondents were more willing to pay for improved seeds, tarpaulins and metal silos for drying and storing grain compared to other regions. Further research is needed into people's willingness to adopt risk-reducing strategies, perhaps through randomised experimental trials to study behavioural responses to different risk-reducing strategies.

Mycotoxins can neither be smelled nor tasted. So testing is needed to determine whether the levels in a product exceed the acceptable safe threshold. Analyses of data collected with an experimental auction (De Groot et al., 2011) demonstrated that consumers were willing to pay a slight premium for maize labelled "tested", and that the premium was positively associated with increased schooling and was higher in affected regions. In Mali, Tiongco et al. (2011) found people also willing to pay a premium for groundnuts tested and labelled free of aflatoxin.

■ Which measures to recommend?

Data on the effectiveness of implementing control measures in the African situation when the Aflacontrol project began was limited. Therefore, an expert elicitation was administered to an expert panel to provide guidance on the potential effectiveness of selected aflatoxin risk

Pre-test of experimental auctions for certified aflatoxin-free groundnuts in Mali.

reduction measures for maize and groundnuts. It was combined with cost data on different storage methods from unpublished CIMMYT survey data and estimated costs of biocontrol from IITA to conduct an analysis of cost effectiveness (see Narrod et al. 2011). The findings revealed a natural order to the value of each option to overall risk reduction. The differences depended not only on stated costs and revealed effectiveness, but also on the lifespan of the option considered (i.e. how often it has to be re-purchased). For instance, for maize, a few low-cost options that need to be replaced on a regular or semi-regular basis, such as drying on tarp, were determined to be cost-effective, as were more expensive options with longer life spans, such as plastic and metal silos. Uncertainty about how often biocontrols were needed resulted in their application only showing up on the frontier if they were not required each year. Findings from the cost-effectiveness analysis need to be interpreted with care until good experimental data on the effectiveness of various measures in the African situation are available and the lifespan of the various methods is established to get a true understanding of their costs.

Efforts are now underway with the Aflacontrol team members, Partnership for Aflatoxin Control in Africa (PACA), the CGIAR Research Program on Maize and regional trade organisations such as COMESA to build on the Aflacontrol project and other initiatives. These



Photo: M. Tiongco

efforts seek to understand the effectiveness of existing measures, update cost-effective analysis and implement a study to improve the availability of safe maize through implementation of science-based interventions to reduce aflatoxin and fumonisin (another group of fungal toxins) as well as building local capacity to reduce mycotoxin exposure. Also, efforts are underway to work with African nationals in areas such as educating families, farmers and governments about health risks and what reducing them would cost, lowering the risk of contaminating of maize by adopting appropriate practices, building local capacity to support reducing mycotoxins in agricultural produce and providing tools for locally-driven policy reform ensuring food safety and trade opportunities in the region. Investments need to focus on providing appropriate information and education to different stakeholders as well as an enabling environment to build local capacity.

Marketing local rice to African consumers

As food import dependency has grown, many African countries have attempted to boost local agricultural production. With rice production increasing in Senegal, organisations are progressively upgrading rice value chains in order to compete with imports. Yet investors are now grappling with ways to raise demand for their product. How should local rice be marketed to African consumers?

Senegal is one of the most food-import-dependent countries in sub-Saharan Africa, especially when it comes to rice, a main staple of the diet. It is the third largest rice importer in Africa, after Nigeria and Côte d'Ivoire. In 2011, rice was the greatest agricultural import in the country, about 39 per cent of its total agricultural imports. Around 61 per cent of Senegal's rice consumption is currently met via imports, which has drawn the government's attention to local production. In recent years, the Senegalese government and other organisations have poured money into increasing production. However, while they are expanding production and enticing investment in the rice industry, there has also been recognition that production alone is not a comprehensive solution. Organisations recognise the need to upgrade Senegalese rice

value chains in an attempt to compete with imported rice, by creating greater demand for local rice. Imported rice still dominates the market in much of the country, and many Senegalese still view local rice as inferior in quality to imported rice.

However, as organisations begin to develop marketing strategies for local rice, there is little material for them to employ. Organisations are now facing the question of how to effectively market local rice to consumers. For example, what are the most effective strategies for marketing to consumers? What ideas should the promotion target? And what kind of packaging and branding should be used for local rice?

lion, or baobab tree), and are written in Wolof or French. International brands do not use local references, and often reference an international symbol (i.e. a rose, chandelier, or the American flag), and are written in English or French. Based on this information, we developed eight prototypes of rice brands and, through a participatory choice experiment with two local women's associations (based in Dakar and Saint-Louis), four brands were selected for use in the study: two local (*Ndanane* – "Elegant" and *Sunu Ceeb* – "Our rice") and two international (*Noblesse* and *Happiness*).

Next, a market experiment was conducted in two Senegalese cities, Saint-

Caitlin Costello
Visiting Research Fellow/Fulbright
Research Grantee
Africa Rice Center (AfricaRice)
Saint-Louis, Senegal

Matty Demont
Value Chain Economist
Africa Rice Center (AfricaRice)
Saint-Louis, Senegal
m.demont@cgiar.org

Maïmouna Ndour
Sociologist
Africa Rice Center (AfricaRice)
Saint-Louis, Senegal

■ Comparing rice labels

To address this issue, the research focused on packaging as a marketing tool for local rice. It concentrated on the following question: Should local rice brands mimic imported brands or should they create a distinguishable identity? In other words, should organisations emphasise the local aspect of the product or should they mimic the style of well-known imported rice brands?

In urban markets in Senegal, two different types of brands can be distinguished: "local" and "international". Local brands reference Senegalese or African culture (i.e. a picture of a drum,



Experimental auctions

Experimental auctions act as a tool to measure consumers' WTP for different products. Participants bid to buy actual products using their own money, which incentivises people to truthfully reveal their real value for each product. The experimental auction used in the study, the BDM (Becker, Degroot and Marschak) auction, conducts the auctions individually. Each participant bids against an unknown pre-determined price enclosed in an envelope. If her bid is higher than the pre-determined price premium, she wins the kilogram of the preferred rice brand and pays the pre-determined price premium. If her bid is lower, she does not win the preferred rice brand and takes the initial endowment home.

Louis and Dakar, with a total of 241 urban Senegalese women. The study elicited urban consumers' preferences for international versus local rice brands, as well as differences in willingness to pay (WTP) between the two types of rice brands. We used an endow-and-upgrade experimental auction for the study (see Box). We focused on women as they are the major decision-makers in rice purchasing in Senegal. Female participants were randomly approached on the market to participate in the study

The women's association Khar Yalla Gueye in Pont Gendarme participated in the selection of the prototypes of rice brands. They will soon start commercialising local quality rice through the Ndanane brand.

and were told they would be given one kilogram of rice. Each participant was shown a pair of differently branded rice bags, offered the opportunity to examine the rice in both bags, and asked to state her preference. The rice in both bags was identical, although this was not revealed to participants.

Each participant was then endowed with one kilogram of the non-preferred rice brand, which she had the opportunity to upgrade to her preferred brand. The participant was provided with the market price of the non-preferred rice (400 FCFA/kg or € 0.61/kg) and asked how much she would be willing to pay on top of that price in order to obtain a kilogram of the preferred rice brand. The WTP (to upgrade to her preferred brand) was recorded, and a questionnaire was administered to collect socio-demographic and consumer preference information.

■ Getting to know the consumer

The results show that both types of labels appeal to urban Senegalese consumers, with a higher preference for brands with a local identity. Urban consumers are somewhat more attracted by the local rice brands, which used Wolof brand names and symbols referring to Senegal or Africa. This preference is particularly strong close to the production zone, where consumers are perhaps more connected with local rice production. In Saint-Louis, local brands (68 %) are clearly preferred to international brands (32 %). In the capital Dakar – far-

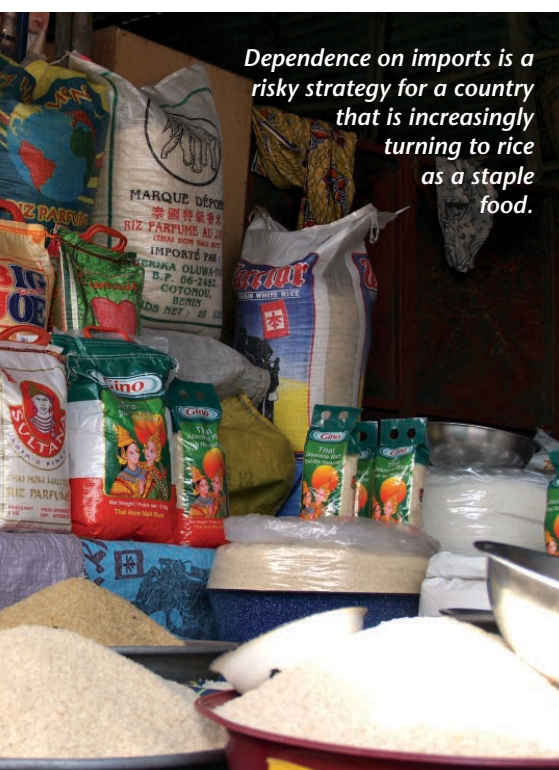
ther from the production zone and close to the port – preferences are somewhat more equally divided between local (57 %) and international brands (43 %).

Greater variations appear when factoring in demographics and consumer preferences. Among those who were weakly brand conscious (those who recognised two or less brands from a chart with nine common rice brands sold in Senegal), 70 per cent preferred the local label. However, among those who were strongly brand conscious, recognising six or more rice brands, only 51 per cent opted for the local label. 70 per cent of women who normally purchased non-fragrant local rice preferred the local brand, but this dropped to 54 per cent for those who normally purchased fragrant, imported rice. Among those who normally purchased *Riz de la Vallée*, a local rice brand, 84 per cent chose the local brand. Yet among those who normally purchased *Royal Umbrella*, an imported rice brand, 60 per cent preferred the local label.

There are also segments of the population that have a strong preference for local labels. Local brands were more popular among women who were poorer, who were weakly brand conscious, and who normally purchased local rice. For example, among those who normally only purchased local rice and whose household income per person was less than 10,000 CFA (€ 15)



Photo: R. Raman, AfricaRice



Dependence on imports is a risky strategy for a country that is increasingly turning to rice as a staple food.

Photo: R. Raman, AfricaRice



Photo: R. Raman, AfricaRice

Durabilis' Terra combines a local brand name (signifying "welcome" or "hospitality" in Wolof) with an international symbol inspired from India.

purchases in Senegal. The results show that 69 per cent of urban women purchase rice by the bag, and only 31 per cent purchase rice by the kilogram. Almost half (45 %) of households choose the rice they purchase by identify-

ing the bag, rather than relying on an examination of grain quality. It was also found that 47 per cent of women identify brands by colours and/or symbols, rather than by the brand name.

per month, 85 per cent preferred local labels. Among those who normally purchased only local rice and were able to name a local rice brand, 75 per cent preferred local labels.

On the other hand, some segments of the population have a stronger preference for international labels. International brands were preferred among women who were wealthier, who were brand conscious, and who normally purchased imported rice. 74 per cent of women who normally purchased only imported rice and were brand conscious, recognising six or more brands, opted for international labels. Among those whose household income per person was greater than 20,000 FCFA (€ 30) per month and who were brand conscious, again recognising six or more brands, 64 per cent preferred international labels.

■ The value of a brand

A significant finding is that consumers were willing to pay an average of 67 FCFA/kg (€ 0.10/kg) to upgrade to their preferred brand, a price premium of 17 per cent. The WTP was similar between local and international brands (69 FCFA/kg and 62 FCFA/kg respectively.) The rice used in both bags was identical; therefore, the label added 17 per cent in value to the rice.

Packaging is a significant part of the decision-making process in rice

■ Recommendations: Using marketing as a tool

Use colours and symbols wisely. A large share of the population identify brands by colours and/or symbols. Accordingly, this should also play a major role in further research and marketing strategies. In Senegal, where women are the main rice purchasers and literacy among women is around 30 per cent, this is an important aspect to consider in upgrading rice value chains.

Be consistent. As Senegalese consumers become familiar with rice brands, they associate each brand with a certain standard of quality. Local rice, however, does not ensure the same reliability. The same rice labels are often used for different varieties, grain sizes, and varying levels of cleanliness. In order to build an effective brand, local rice producers should create different labels for various rice types, and should also ensure the same level of quality in each bag.

Use targeted marketing strategies. Organisations should consider targeting their rice to different segments of the market. For example, organisations may find that international labels

are more successful in supermarkets in Dakar, where consumers are less familiar with local rice and may be more brand-conscious. Conversely, they may find it more effective to use local labels in markets close to production zones, where consumers are familiar with local rice and may be less brand-conscious. An alternative strategy is to target both market segments simultaneously through a "hybrid" brand, such as the Terra brand introduced by the Belgian impact investor Durabilis.

Future research. In order to focus on brand name and concept and to avoid excessive contributing factors, this study used only black and white designs in the labels. Future research should be conducted in order to analyse which bag colours are best suited to both attract Senegalese consumers and create a distinguishable identity for local rice.

■ Conclusion

As organisations recognise the need to upgrade rice value chains alongside production growth, marketing research needs to be an integral part of the solution. The results show that packaging is a significant part of the decision-making process in rice purchases in Senegal, reinforcing the idea that consumers are responsive to labelling. Furthermore, consumers were willing to pay price premiums of 17 per cent for their preferred brand, demonstrating that there must be a greater focus on marketing research as a way to improve the competitiveness of local rice. Marketing is an important tool in adding value to local rice in Senegal, and should be utilised effectively as organisations work towards increasing demand and creating a successful rice sector.

For a previous article on African rice value chains, please visit www.rural21.com

Empowering youth, opening up perspectives

Young people are the future. And they need employment. For many African countries, creating these employment opportunities is a challenge, and in post-conflict states such as Liberia the hope for a sustainable peace adds an additional dimension to the task. A team from the Centre for Rural Development (SLE) visited the south-east of this West African country to look at the specific problems faced by young people and what development cooperation can do to help.

Sunnyboy is sitting in the tin-roofed palaver hut in Boundary Town, the settlement in the county of Grand Gedeh where he lives. “Two to three times a week I’m digging gold in the bush with my friends to make some money,” is the 17-year-old’s response when asked what work he does. He spends the rest of his time clearing the community roads of overgrown vegetation, helping to cultivate the small field where the family of nine grows cassava, rice, taro and sweet potatoes, and selling what little surplus is produced. His spare time is spent at the football club or with friends. The scattered settlement is remote: the two nearest towns, where markets and educational opportunities are located, are some 30 kilometres away – even with a motorbike the journey can take up to two and a half hours in the rainy season. Transport is limited: very few young people have a motorcycle, let alone a car. This – and his father’s illness – is the main reason why Sunnyboy is not attending college or pursuing vocational training.

Jonathan Julius Ziebula

**Joscha Albert, Emil Gevorgyan,
Eva Jünemann, Elisabetta Mina,
Dr Ekkehard Kürschner (Team Leader)**
SLE – Centre for Rural Development
Humboldt University Berlin, Germany
sle@agrar.hu-berlin.de

Rural 21 – 01/2013

■ Informal employment predominates

Sunnyboy’s situation is typical of that of young people in the counties of Grand Gedeh, River Gee and Sinoe in the predominantly rural south-east of Liberia: with formal employment hard to come by, many turn to self-employment and take on a range of different types of work in the informal sector, where jobs are often insecure and working conditions poor. Many young women earn their money through petty trading, while young men drive motorcycle taxis or, like Sunnyboy, hire themselves out as gold diggers or day labourers. Almost 60 per cent of young people state that they are engaged mainly in farming. Long-term business

plans, entrepreneurial skills and basic financial literacy are rarely a feature of these various activities. Moreover, among the young farming is regarded as an unprofitable task that is best left to the uneducated and the elderly.

According to the World Bank only five per cent of working Liberians are employed in the formal sector. Employment opportunities are few and young people often lack the work experience to apply successfully for jobs: “It is difficult to get work experience, so many people, even educated [ones], are forced to do small business because they have no other chance,” says Joseph

Formal employment is out of reach for many young people in Liberia. Young men often earn money with motorcycle taxis.



Photo: J. Ziebula

Promoting youth employment

What can stakeholders and development cooperation partners in Liberia do to promote employment for young people? Traditional strategies such as expanding vocational training, gearing training to the labour market and supporting the development of the private sector are one way forward. In addition, the following specific areas of intervention emerged in the course of the study:

- Strengthening young people's existing self-help initiatives; using youth groups as a starting point for employment-promoting measures, such as promotion of work-related life skills, or to maintain buildings and roads.
- Making farming more attractive as an income-generating opportunity; promoting selected value chains and improving entrepreneurial skills.
- Promoting and using local radio stations as a means of communicating labour market information, providing training and running awareness campaigns for young people.
- Improving the opportunities for transporting agricultural products to local markets through cooperation between farmers, motorcyclists and youth groups.
- Helping local entrepreneurs in the construction sector to provide training opportunities and practical work experience for young people.
- Setting up childcare facilities at schools and training centres in order to improve women's access to education.

Tanyon, headmaster of a high school in River Gee, as he describes this vicious circle. It is true that foreign companies are likely to create a large number of new jobs over the next few years, many of them for unskilled workers. However, many young people would prefer insecure self-employment to the poor working conditions often encountered on oil palm plantations or when logging in the rain forest.

■ Aftermath of the civil war

Local youth experts and employers state that as a result of the 14-year civil war, some young people find it hard to

resolve conflict peacefully, make long-term plans or keep agreements. This can render them incapable of coping with the demands of education, work and family life. They also need help to find renewed purpose and direction in their lives. Apart from the psychosocial support provided to young women by the German non-governmental organisation (NGO) *medica mondiale*, there are no treatment opportunities in the region for young people who have been traumatised or mentally disturbed by the violence they have experienced.

■ Training opportunities limited and hard to access

The employability of the young is reduced not only by lack of work experience but also by their limited education and training. The causes are complex. Many young adults became embroiled in the civil war as participants and victims and received no basic education. According to the government, the illiteracy rate in the 25–34 age group in Sinoe County is almost 60 per cent – almost twice as high as in the 16–24 age group. Another cause is the limited availability of training outside the capi-

tal: in the three counties the only facilities for vocational training are at two state-run high schools and three centres run by the Danish NGO IBIS. Getting to these training centres is difficult for young people in remote places such as Boundary Town. Schools are usually poorly equipped, and well-trained teachers prefer to work in the capital, Monrovia: in rural areas state employees must often travel long distances to receive their pay, flown in by helicopter.

In addition, family commitments often stand in the way of regular attendance at class: "People cannot send their children to school because they need to help their parents [...]," comments James Daryours, pastor in River Gee. Young women are particularly affected, especially as childcare facilities are inadequate: only 16 per cent of the young women questioned said that they had completed high school – this contrasts with the figure of 36 per cent among their male contemporaries.

Although the shortage of jobs has a detrimental effect on some young people's motivation, education and training are held in high regard by Liberian youth: many describe a young person as successful if he or she is well educated, and almost all would like to train for a career. It is therefore not surprising that education is an even more powerful driving force for migration to the cities than employment. Almost two-thirds

Young people in Liberia

While the United Nations defines a young person as someone between the ages of 15 and 24, the Liberian government uses the definition of the African Union's African Youth Charter, which classes young people as those between 15 and 35. According to this definition more than 28 per cent of Liberia's 3.5 million people are young people. All were affected by the lengthy civil war (1989–2003).



of those questioned would like to leave their home district. Most set their sights on the capital, but making the move is not easy.

■ Infrastructure as the major bottleneck

Much of Liberia's infrastructure was destroyed in the 14-year civil war. The deficiencies are still visible. There is correspondingly high potential for the construction sector: foreign investors are expanding the transport network on a large scale and NGOs such as Welthungerhilfe are helping to build and equip schools and repair and maintain feeder roads. These projects could provide opportunities for young local entrepreneurs. But achieving this is difficult. Spare parts and building materials must be delivered from Monrovia; in the rainy season they literally get stuck in the mud. Maintaining buildings and roads also presents a challenge: "For everything you build, an association is needed to maintain it," says Dirk Raateland, a Welthungerhilfe worker in Grand Gedeh, as he describes the need to anchor such measures in the community.

■ Social organisation as a livelihood strategy

Whenever possible, people try to help themselves: many young people

Background of the study

As part of the cooperation between Liberia and Germany, the Reintegration and Recovery Program has been supporting development and reconstruction in three counties in the south-east of Liberia since 2005. The programme, which is financed through KfW Entwicklungsbank, is being implemented by Welthungerhilfe with the two cooperation partners medica mondiale and IBIS. The third phase of the programme is addressing infrastructure, agriculture, education and sexual and gender based violence. To enable young people to be more involved as a target group in future, Welthungerhilfe commissioned the SLE to conduct a baseline study of young people and employment. The study explored the situation of young people, relevant economic sectors, education and vocational training and other services. Some 350 young people provided information about their employment situation and life circumstances in interviews and focus group discussions.

support their communities by roadside brushing like Sunnyboy or helping disadvantaged neighbours such as widows in their fields. Youth organisations and sports clubs play an important social role: almost three-quarters of the young people questioned are active in clubs and organisations – often ones that they have set up and organised on their own initiative. Among the activities in which they are engaged sport, especially football and kickball, plays a key part as a unifying element. According to the young men and women who belong to two sports clubs in River Gee, clubs not only contribute to the personal development of every member but also promote peace and reconciliation in Liberia. In addition, many young people are involved in drama groups, organise concerts or help to raise awareness of issues such as HIV/Aids and hygiene.

The lack of formal financial services – in the three counties with their 300,000 inhabitants there are just two bank branches – is also countered by self-help: almost a fifth of the young people manage to take out small loans through the rotating funds system of savings clubs known as Susu Clubs. Many more would like to join a Susu Club. But however well organised the youth clubs and savings groups may be, their limitations are obvious: if organisations have

their own premises, they are frequently dilapidated. The meagre equipment is often funded through small subscriptions or individual donations. For example, journalists at the community-based radio station Radio Gee record their interviews on a mobile phone and need to decide each day whether they will broadcast or produce – they have only one computer.

When asked about his future, Sunnyboy replies immediately: "I would like to earn enough money to provide my family and me with everything that we need." Many young people in the south-east of Liberia dream of a better future – as successful businesspeople, farmers, politicians or students. Ellen Johnson Sirleaf, Liberia's president, is aware of this and emphasised support for young people in her second inaugural speech in 2011: "The youth of Liberia are our future, and they sent us a message. They are impatient. They are eager to make up for years of conflict and deprivation."

FURTHER READING:

Ekkehard Kürschner et al.: Empowering Youth, Opening up Perspectives – Employment Promotion as a Contribution to Peace Consolidation in South-East Liberia. Berlin: SLE 2012. Download: <http://www.sle-berlin.de/index.php/de/studium/publikationen/studien>



Photo: J. Ziebal

In the rainy season even a short cut becomes a difficult, time-consuming affair.

Water storage: a contribution to climate change adaptation in Africa

Water storage can help to safeguard livelihoods and reduce rural poverty. However, ill-conceived water storage will fail to deliver intended benefits and, in some cases, may worsen the negative impacts of climate change. More systematic planning is required to ensure suitable storage systems that support development targets, as an international research project demonstrates.

To provide water for households, agriculture and energy, diverse ways of storing water have been applied all over the globe. Researchers from Europe, Ethiopia and Ghana considered how this diversity could better contribute to food security and poverty reduction under conditions of climate change. They have developed the concept of a water storage continuum (see Figure on page 39).

When it is abundant, water can be stored in reservoirs, aquifers, soil and wetlands. Technical devices, such as pumps or dam outlets, enable this water to be used during drier periods. Importantly for agriculture, water can also be withdrawn directly from soils by plants and crops. Each type of water storage has its own niche in terms of environmental and social impacts. The impact of different types of storage on poverty and food security can vary significantly, with some options being more effective

than others. There is no best option per se but only a best option for a specific location at a specific time. To determine what this best option is, a number of

variables need to be considered. These include the cost of the water storage, environmental and health risks, politics and social-economic factors.



Irrigation canal.

Irit Eguavo

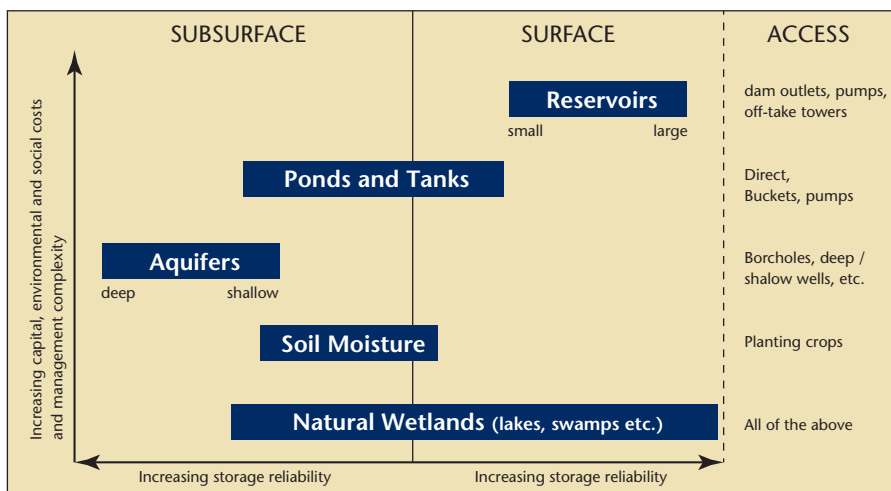
Center for Development Research
University of Bonn, Germany
eguavo@uni-bonn.de

Matthew McCartney

International Water Management
Institute, Vientiane, Lao PDR
m.mccartney@cgiar.org

Photo: I. Eguavo

The water storage continuum



■ The evaluation of water storage

In assessments for development cooperation, information on different variables is combined, based on cost-benefit analysis. The focus is, however, put on one option, rather than on a system of options with diverse components. The project “Re-thinking Water Storage for climate change adaptation in sub-Saharan Africa” (see Box below) suggests an alternative evaluation method called outranking, which fulfils the principle of efficiency but is based on more diversified variables and evaluation techniques to highlight the advantages and disadvantages of a storage option within a specific context.

Time is an important variable. The construction of large dams tends to interrupt agricultural production for a few seasons, especially when resettlement, land reallocation and new crops are part of the dam project and former activities, such as livestock rearing, cannot be pursued any longer. Farm households depend on compensation payments to bridge the intermediate period and are at serious risk of impoverishment. These risks finally diminish when the farmers generate financial benefits of the water storage after having been able to assess their new land plot, been connected to an irrigation

canal and gained experience with irrigation and finding good markets. Usually, additional investment in non-farm employment opportunities is required to provide a livelihood for those who cannot participate in the project. If these opportunities are not forthcoming, a number of targeted beneficiaries may remain trapped in poverty.

Immediate benefits can be generated in projects where the population is involved in work programmes such as terracing and the construction of small dams which provide opportunities for poor rural communities. Often, these schemes are food-for-work initiatives, but if farmers are paid, the money provided may serve to settle debt, repair houses and invest in agricultural and household equipment, as well as in livestock, education, health or weddings. Findings from Ethiopia show that farm-

ers were able to negotiate the amount of money with local authorities. Small dams do not necessarily result in the reallocation of land. Compensation claims and management problems are more easily settled at local level. Usually, rainy season cultivation continues and is expanded to dry season farming once the water is available. But small dams are not a panacea. If badly designed, they fail, and there are many instances where small dams have promoted malaria.

■ Lack of integrated planning

Since the impacts of climate change are uncertain it may be best to build on the complementarities of different storage types, and, in any given location, the best approach may be a combination of different storage options. The first step in the project was to compile data on all storage types in the Blue Nile basin of Ethiopia and the Volta basin in Ghana. There is a tendency to approach water storage from a purely technical perspective, concentrating on hydrology, crop productivity or environmental consequences in studies on single technical solutions. It is rare for all these issues to be considered together and even rarer for the social and political aspects to be incorporated. The researchers attempted to bring these aspects together in an integrated fashion.

Compilation of data from the two river basins revealed some common

The project

“Re-thinking water storage for climate change adaptation in sub-Saharan Africa” (2008–2011) was part of a research initiative co-ordinated by the GTZ Advisory Service on Agricultural Research for Development (BEAF) and funded by the German Ministry for Economic Cooperation and Development (BMZ). The studies were realised by a consortium including the International Water Management Institute (<http://africastorage-cc.iwmi.org>), Arba Minch University, the Ethiopian Economic Association, The Water Research Institute in Ghana, the Institute of Statistical, Social and Economic Research at the University of Ghana, the Center for Development Research at the University of Bonn (<http://www.zef.de/1393.html>), as well as the Potsdam Institute of Climate Impact Research.



Photo: S. Marx

This boy's family had to relocate for the construction of the Koga dam. Many farmers say that they are considering moving to Merawie town to improve their children's education.

a key role in ascertaining the possible implications of changing temperature and rainfall for existing and planned water storage in both river basins.

These studies showed that in both basins, despite continuing great uncertainty about how climate change will impact the water resources, the technical performance of large reservoirs is likely to be adversely affected by the changes in climate. Although investment in reservoir storage brings benefits, both in terms of irrigation and hydropower production, these benefits are significantly reduced as a consequence of climate change. The changes are likely to have significant consequences for economic development and food security in both river basins. Against this background, water resource development requires interventions that bolster resilience and water security. This necessitates much more systematic planning, greater co-operation between the riparian states in each basin and consideration of innovative approaches to water storage, such as managed aquifer recharge.

practices and knowledge gaps, which likely represent the current situation in many African countries. Despite the fact that researchers, policy-makers and development agencies recognise the importance of water storage for economic development, there is a considerable lack of reliable information on both existing and planned storage. For both basins, basic understanding (e.g. of groundwater availability and groundwater recharge) is insufficient or simply lacking. Data and information for a range of storage types are unavailable or dispersed and difficult to access. With the exception of large dams, past storage development has occurred in a piece-meal fashion, largely through local initiatives and with minimal planning. It is generally characterised by absent or poor data management and little communication between local stakeholders, research

communities and water resources authorities, and lack of any integrated planning. From the review, it was clear that this gap had led to less than optimal investments. From an academic perspective, there are too few articles that discuss the synthesis of research findings on various storage options and from a multidisciplinary angle giving adequate consideration to social and political concerns. And more effort is required in translating the research findings for a non-scientific readership.

■ Options under climate change

The research aimed to bring together all sorts of information and knowledge, including local characteristics, different disciplinary approaches, as well as the diversity of water storage options. In addition, climate modelling played

■ Lessons from the Ethiopian Blue Nile

In addition to climatic and hydrological modelling, the project conducted ethnographic and economic research. The typical options for water storage in the Blue Nile basin are dams, terraces to increase soil moisture, tanks, river diversion, wells and ponds. The studies dealt with distributional conflicts over land and water, gender relations, as well as the acquisition and management of storage facilities, for example in the vicinity of large dams, such as the Koga dam, and in the Fogera Plains.

Fogera on the eastern shore of Lake Tana is a landscape that will be transformed in the near future as a consequence of the construction of dams for large-scale, commercial irrigation and hydro-power generation. The studies conducted for this project analysed the current diversity of water storage and will continue to observe the changes in the plains as a result of the on-going large dam projects. Fogera is located in a larger region where the German government is taking the initiative to establish a UNESCO biosphere reserve in co-operation with the Michael Succow Foundation, the Nature and Biodiversity Conservation Union (NABU) and Ethiopian partners, including the national government.

In the Fogera plains, despite similar social-political conditions and the same administrative framework, irrigation facilities are established and managed differently. Currently however, all water storage is small-scale and managed by users. Farmers are already perceiving changes in climate and believe it is having a negative impact on agricultural production. Many farmers are taking the initiative to develop new water storage and irrigation infrastructure, but often, they are reliant on assistance from government and NGOs.

Understanding the adaptive capacity of local communities and how this might change as a consequence of different water storage options is a prerequisite for choosing best options for the future. If given the opportunity, farmers will take some initiative in developing ways to minimise the ecological and economic risks arising from the installation of storage. Better communication with farmers, local authorities and donors is a precondition for community support and “buy-in” for local initiatives. The “Re-thinking Water Storage” project indi-

cates the value of farmers’ initiatives. It argues for an approach that extends storage capacities and considers small and large schemes as complementary, instead of eradicating existing systems as a side effect of large dams.

■ Consideration of different development targets

The priority to increase agricultural production may contradict other development objectives. The biosphere reserve initiative, for example, underlines the importance of the wetland (in particular Fogera) around Lake Tana in terms of biodiversity hotspots and the regulation of ecosystem functions, and as a source of local livelihood and an important carbon store. The initiative equates drainage and land use change for irrigated agriculture and livestock keeping with wetland degradation. Its feasibility study concludes that free grazing, crop production and eucalyptus plantations must be better controlled and that awareness building among the rural population on the “wise use and ecological benefits” of wetlands would be advisable.

Studies of the “Re-thinking Water Storage” project, however, have shown that it is the Ethiopian government that has decided to transform large parts of the Fogera Plain into irrigation

schemes. In fact, the government has identified the Tana Basin as part of an “economic growth corridor” for which investment is being targeted for socio-economic development of the country. This includes investment to increase agricultural production. Farmers are not involved in any form of political decision-making that concerns the future of their region. Currently, there is no local civil society response to the large dam projects and practically no co-determination by the donor community because Ethiopia does not depend much on these factors in its water development.

This is not meant to say that the expansion of irrigation is necessarily inconsistent with the conservation of biodiversity around Lake Tana. The findings emphasise that a debate on the suitability of technical options across different research communities is necessary to suggest measures that contribute equally to different development goals and climate change adaptation and reduce the impoverishment risks of interventions. The key is more systematic and integrated planning at all scales without losing sight of the political conditions. If planned and managed correctly, water storage in its various forms, including wetlands, can make a vital contribution to increased agricultural productivity, nature conservation and adaptive capacity throughout Africa.

Project staff and farmers in the Koga irrigation scheme, Ethiopia.

Photo: I. Eguavoen



Mapping hotspots of marginality for area identification

The Center for Development Research (ZEF) of the University of Bonn seeks to identify opportunities for marginalised rural farming communities to escape poverty by means of appropriate technologies in agriculture. With the aid of overlapping maps of marginality and poverty, the researchers can demonstrate where the greatest need for action is.

Marginality is one of our core research programmes which focuses on people living at the edge of society and having no or limited access to markets or networks to fulfil their basic needs. Through hotspot mapping, poor and marginal areas can be identified where innovations in agricultural technologies could potentially improve rural livelihoods faced by degrading soils, lack of capital or limited access to markets. By mapping regions with low endowments of important factors of a livelihood, we are highlighting areas where more research is necessary to improve rural lives, especially in cases where they can be enhanced by better agricultural productivity.

■ The dimensions of marginality

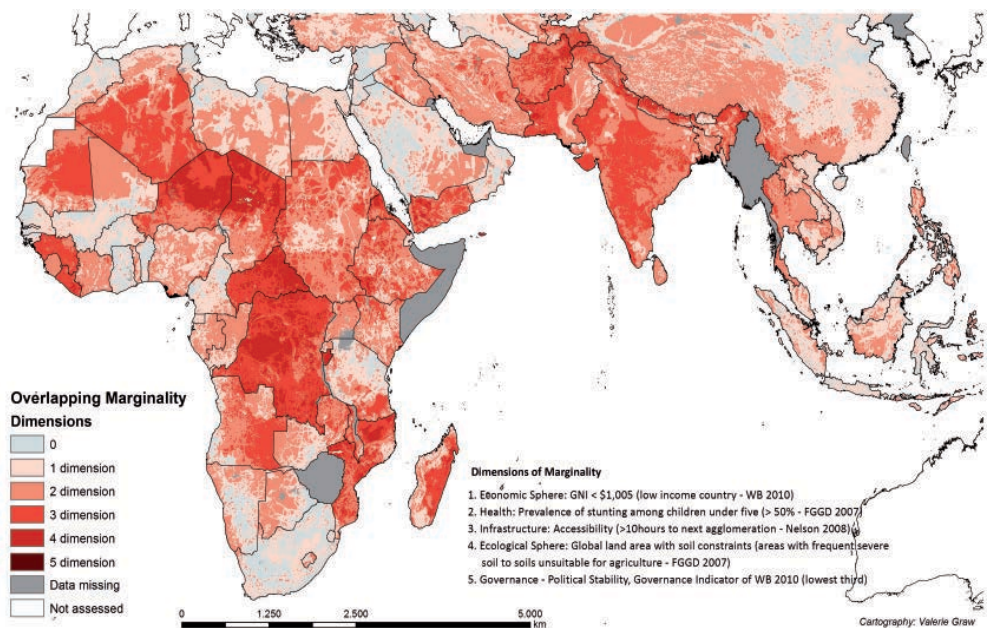
Marginality is not equal to poverty. It is more about the underlying causes of poverty. Referring to Gatzweiler et al. 2011, Graw & Ladenburger (2012) described different dimensions of marginality represented by an economic, demographic, quality of life, landscape design, infrastructure, ecological and a public domain dimension. For each of these dimensions one representative indicator was chosen. The indicators within the dimensions of marginality are furthermore defined by cut-off points of

the certain variable. An area is stated to be marginal below or above the chosen cut-off point, depending on the indicator. Within the same study, the cut-off points were chosen by literature review and country statistics to find the areas which tended to be marginal.

The economic variable was represented by Gross National Income (GNI) per capita. According to the World Bank Atlas Method, an economy is referred to as a “low economy” if the GNI per capita is below 1,005 US dollars a year (World Bank 2011), which we therefore used as cut-off point. The health dimension was represented by prevalence of stunting (low height for age) among children under five, showing chronic malnourishment.

To measure infrastructure and accessibility, we chose a dataset generated by Nelson (2009) showing travel time to the next agglomeration of 20,000 people. As it was difficult to answer the question “How far is far” we used the least third quantile to represent the marginal dimension of accessibility. A dataset by FGGD (Food Insecurity, Poverty and Environmental Global GIS Database) on global land areas with soil constraints was used to identify areas with frequent severe soils for agriculture and areas which are unsuitable for agriculture. This dataset was used for the representation of the ecological sphere. For the public domain dimensions, we focused on the aspect of governance which could best be represented by political stability, also a governance

Marginality hotspots



Valerie Graw
PhD Researcher
Center for Development Research (ZEF)
University of Bonn, Germany
valerie.graw@uni-bonn.de



Photo: J. Boethling

Marginality is multifaceted and much more broadly defined than poverty.

the number of poor and marginalised, we preferred poverty mass instead of poverty rates.

A dataset provided by Harvest Choice was used to overlay poverty mass with marginality hotspots (map below). We found marginality hotspots in India and Bangladesh as well as in East and West Africa. This analysis of marginality hotspots is important to contribute to our partners' work in our partner countries. The TIGA project (Technology assessment and farm household segmentation for inclusive poverty reduction and sustainable productivity growth in agriculture) now uses this approach on a subnational scale with a focus on four partner countries: Ethiopia, Ghana, Bangladesh and India (the two states of Bihar and Odisha).

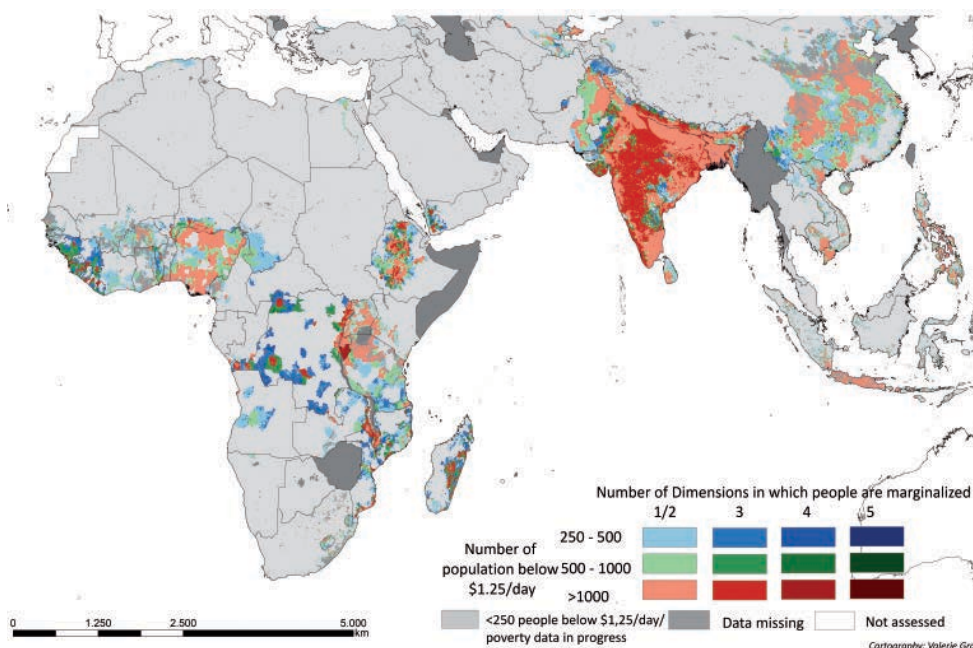
indicator of the World Bank, as it is one of the variables which "measures the perception of the likelihood that the government will be destabilised by unconstitutional or violent means" (Thomas 2010).

■ Linking marginality to poverty

By overlaying the different dimensions – based on the cut-off-points – we were able to identify in how many dimensions an area was marginal (map on the left). In a second approach, we took a closer look at how many poor people were living in these hotspots and were therefore affected by marginality and poverty. As we wanted to focus on

More information and a list of references: www.rural21.com

Marginality hotspots and poverty mass



Imprint

Rural 21 –
The International Journal for Rural Development

Published by:
DLG-Verlag GmbH
Frankfurt, Germany

Advisory council:
Dr Albert Engel, GIZ
Dr Reinhard Grandke, DLG
Dr Stefan Schmitz, BMZ

Editorial committee:
Dr Michael Brüntrup, DIE
Lüder Cammann, GIZ
Dr Christine Chemnitz, Heinrich-Böll-Stiftung
Maren Kneller, BMZ
Karl-Martin Lüth, DLG
Prof. Dr Matin Qaim,
University of Göttingen

Editor in chief:
Silvia Richter, s.richter@dlg.org

Editorial staff:
Olive Bexten, o.bexten@dlg.org
Ines Lechner, i.lechner@dlg.org
Angelika Wilcke, a.wilcke@dlg.org

Editorial office:
DLG-Verlag GmbH
Eschborner Landstraße 122
60489 Frankfurt, Germany

Translated by:
Michael Gardner
Christopher Hay
Tazir International Services

Distribution, advertising:
DLG-Verlag GmbH
Eschborner Landstraße 122
60489 Frankfurt, Germany

Layout:
Petra Sarow,
Munich, Germany

Printed by:
Brühsche Universitäts-
druckerei GmbH & Co KG
Wieseck, Am Urnenfeld 12
35396 Gießen, Germany



Rural 21 is published four times per year. The subscription rate is 33.– Euro (Germany), 37.– Euro (EU countries), 51.– Euro (non-EU countries) and 8.30 Euro per issue, plus postage. All rights reserved. The contents may not be translated, reproduced in whole or in part, nor may information be passed on to third parties without permission of the publisher. Please direct all correspondence to the editor in chief.

The opinions expressed by the authors are not necessarily those of the publisher or the editor. The editor retains the right to make editorial changes.

Visit our website: www.rural21.com



The new Rural 21 website offers up-to-date information on the latest developments. Topics that are at the heart of international discussions and lively debates about current issues.

We look forward to your visit to www.rural21.com