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# Achieving zero hunger through zero wastage: An overview of present scenario and future reflections

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ABSTRACT

Worldwide nations and development organizations are now concentrating their efforts on giving nutritional and secure food to the population all over the world, especially to the malnourished people in the developing and under developed countries. Minimizing post harvest losses of agricultural produces is an imperative strategy needed to be adopted in the present scenario to meet the requirement of increased demand of food and nutritional security in a sustainable way. Because about 1.3 billion tonnes of food is lost and wasted globally every year, and one-third of all food produced, is lost or wasted in food production and consumption due to the lack of proper storage facilities, marketing facilities and many other reasons. Present article is an attempt to document the overview of global post harvest losses, in general and India's post harvest loss scenario, reasons for post harvest loss and strategies to mitigate it in particular.

**Key words:** Food security, Post harvest loss, Strategies

World population is set to grow considerably over the coming years and is predicted to reach 9.3 billion by 2050, with a projected increased food demand of 50-70% (Bruinsma 2009, Jaspreet Aulakh and Anita Regmi 2013). Against this backdrop of rising demand, 12.5% of the world's population (868 million people) are chronically malnourished, equating to one in eight people global fall outside of the food security regime (Naylor 2011, FAO 2013, Slideshare 2014). According to UN, food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Summit 1996). This includes the availability, access, utilization of food and stability of all these three elements in the future. Several measures have been suggested to meet the increasing challenges of feeding the world's population and increasing food security in a sustainable way (Godfray *et al.* 2010, Foley *et al.* 2011). Reducing food loss and wastage is one of the most important measures among them as about 1.3 billion tonnes of food is lost and wasted worldwide every year, and one-third of all food produced, worth about US$1 trillion is lost or wasted in food production and consumption (Mundial 2008, Trostle 2010, Foresight 2011, Bond *et al.* 2013). The magnitude of post harvest food loss is calamitous which includes a waste of valuable farming inputs like water, energy, land, labour, and capital. The importance of natural resources used to produce lost and wasted food products has been increasingly highlighted in many studies (Lundqvist *et al.* 2008, Lundqvist 2010, Gustavsson *et al.* 2011). Further the threat to food security, post-harvest losses harmfully affect farmers and consumers in the lowest income groups with the tragic loss of farmer income, and harm to economic growth.

According to Joris Tielens and Jeroen Candel (2014), the relationship between food wastage and food security is a complex one. It is having economic, environmental and social perspectives on this relationship. Special effects can also be distinguished at a micro-, meso-, and macro-level. The linkage between reducing wastage and food security can be direct and short term, or indirect and long term. Additionally, actions may have an effect on different aspects of food security such as availability, accessibility, utilization and stability of food. UN Zero Hunger Challenge, a global campaign to raise awareness and eliminate hunger concluded that 'food loss and waste reduction is one of the most effective ways of improving global food supply, thus contributing to enhanced food and nutrition security', without further specification of the relationship itself ( FAO 2013).

*Post-harvest loss and wastage*

Post-harvest Food Loss (PHL) is defined as measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest till its consumption or

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other end uses (Hodges *et al.* 2011). Even if this common definition is present, significant differences in definitions of food losses, wastage and waste exist (FAO 1981, Lundqvist *et al.* 2008, Parfitt *et al.* 2010, FAO 2011a). Food losses refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, post harvest and processing stages in the food supply chain (Parfitt *et al.* 2010). Food losses occurring at the end of the food chain (retail and final consumption) are rather called "food waste", which relates to retailers' and consumers' behavior. (Parfitt *et al.* 2010, Gustavsson *et al.* 2011). In Table 1 the percentage wastage of the harvested agricultural products in different stages of post harvest management chain, starting from the harvest to consumption has been mentioned.

Table 1 Percentage loss at different stages of post harvest management chain (FAO 2013)

| Stage | Loss (%) |
|---|---|
| Harvesting | 5-8 |
| Handling operation | 15-20 |
| Storage | 5-10 |
| Transport and consumption | 10-12 |
| A theoretical total | 35-50 |

According to Gustavsson *et al*. 2011 (as represented in Fig 1 and Fig 2), post harvest loss pattern of agricultural products in developing and developed nations differs a lot. Developed countries waste fewer amounts of agricultural and allied products at the field level than the developing nations and industrialized Asian countries. But at the consumption level, food wastage is much more in developed nations (22%) than the developing nations (<5%). In developing countries, pre-harvest losses occur through significant yield and livestock losses, from a lack of resilience and control of natural assaults (biotic and abiotic stresses) characterised by basic agricultural inefficiencies and technological limitations. Post harvest losses (PHLs) in developing countries are sizeable due to poor storage

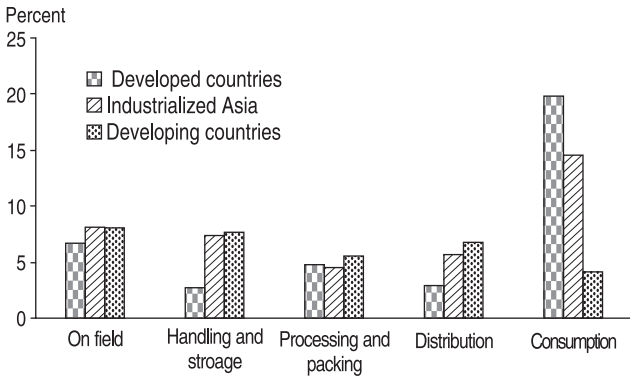


Fig 1 Per cent loss at different stages of post harvest management chain in developed, industrialized and developing countries

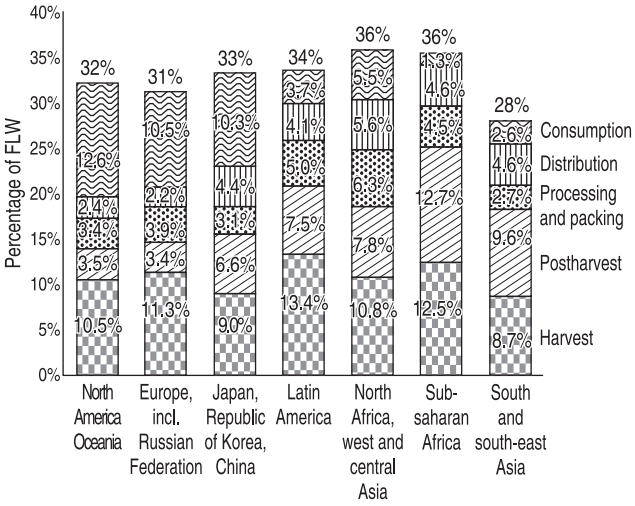


Fig 2 Per cent loss at different stages of post harvest management chain in different countries

facilities and frequent infestation from rodents, pests and diseases. Dry and cold storage facilities provide farmers and growers with more market flexibility (e.g. not having to sell grain as soon as it is harvested) and economic benefit (e.g. reducing losses and improving overall produce quality).

Depending on the products and the regions, the distribution of the losses and waste along the food chain is extremely different. Significant losses occur early in the food supply chains in the industrialized regions. In industrialized countries, various technical, legal, fiscal and organizational barriers refrain from using food more efficiently. For example, some hygiene rules within European, private and public regulations have been identified as a major reason for throwing away food in the catering industry due to very wide safety margins that companies apply (Waarst *et al.* 2011). In medium- and high-income countries food is, to a significant extent wasted at the consumption stage like food after cooking or in plate, meaning that it is discarded even if it is still suitable for human consumption. Nearly 30% of the wastage is by this way only. India is also contributing to this by wasting food in social gathering and functions (Sharma *et al*. 2013). But in low-income countries, food is lost mostly during the early and middle stages of the food supply chain; much less food is wasted at the consumer level (Hodges *et al.* 2010, Parfitt *et al.* 2010, FAO 2011a, Kummu *et al.* 2012).

*Scenario of post-harvest loss in India*

India is one of the most important developing nations with fastest growing economies of the world and is currently the focus of a great deal of international attention (European Commission 2007). India is probably the only country in the world where numerous crops are grown and animals are reared. It contributes about 13.7% to the gross domestic product of the country and about 65% of the population still relies on agriculture for employment and livelihood.

India's food grain production has more than doubled over the decades to a record 264.4 million tonnes in 2014 (India Budget 2014). But the processing sector in the agricultural field is still at the embryonic stage because only 2% of the total agricultural productions is being processed (Corporate Catalyst 2015). The processing level is higher for pulses and oilseeds at 75 and 90%, respectively. However, the processing in India is mainly through unorganized sector using the traditional methods and age old equipment leading to substantial quantitative and qualitative losses. According to Sinha (2010), losses after harvest due to poor infrastructure and unorganized retail lead India to experience some of the highest (over 35 to 40%) food losses in the world. Following harvest, about 60-70% of food grain is stored on farms for variable periods, normally in traditional structures and at dangerously high moisture levels. This makes them particularly vulnerable to infestations of pests and micro-organisms. Significant losses also occur during processing, where the number of mills is insufficient to meet demand, and most processing units are small and use outdated technologies. Further, adequate attention has not yet been paid to quality, hygiene and packaging. Post-harvest huge losses of fruits and vegetables are a matter of grave concern for India's agriculture sector. Fruits and vegetables are highly perishable commodities and about 30% of them produced in the country are rendered unfit for consumption due to spoilage after harvesting where there is a lack of proper storage facilities, absence of proper handling, transportation, pre- and post harvest treatment and processing. India's post-harvest fruit and vegetable losses are over ₹ 2 lakh crore annually, owing to inadequate cold storage facilities and lack of proper food processing units. Among the states which witness maximum of post-harvest losses, West Bengal ranks at first position with losses worth ₹ 13600 crore each year, followed by Gujarat with losses to the tune of about ₹ 11400 crore, Bihar at more than ₹ 10700 crore, Uttar Pradesh at ₹ 10300 crore and Maharashtra at ₹ 10100 crore (Business-standard 2013, The Economic Times 2013). Therefore, reducing the scale of losses and waste throughout the entire food system is a crucial step towards improving country's food security.

*An overview of reasons of India's post harvest wastage*

The reasons of post harvest wastage differ all around the world and they mostly depend on the location and specific conditions of a given country (FAO 2011). Loss occurs at every stage of the supply chain. Factors that contribute to food loss range from mechanization of practices such as harvesting to handling, processing and others, to climate change, unfavourable production environments, production practices, management decisions, transportation facilities, grading issues, infrastructure, consumer preferences/attitudes, poor institutional support and poor access to post harvest technology and resources as consequence of poor governance systems and availability of functional markets (Sharma *et al*. 2013).

*Lack of proper infrastructure:* The importance of infrastructure in agriculture and rural development is well documented. It is estimated that 15% of crop produce is lost between the farm gate and the consumer because of poor roads and inappropriate storage facilities alone, adversely influencing the income of farmers (World Bank 1997). When rural infrastructure is deteriorated or non-existent, the cost of marketing farm produce can be prohibitive for poor farmers. Poor rural infrastructure also limits the ability of traders to travel to and communicate with remote farming areas, limiting market access from these areas and eliminating competition for their produce. Construction of rural roads almost inevitably leads to increase in agricultural production and productivity by bringing in new land into cultivation (fallow land into cultivable land) or by intensifying existing land use to take advantage of expanded market opportunities. In addition to facilitating agricultural commercialization and diversification, rural infrastructure, particularly roads, consolidate the links between agricultural and non-agricultural activities within rural areas and between rural and urban areas (IFAD 1995). Apart from mobilising people, infrastructure is also necessary to organise input supply, finance, and post production processing and marketing of the produce.

*Lack of cold storage facilities:* One of the most critical constraints in the food processing industry in India is the lack of integrated cold chain facilities. The Indian agricultural sector is witnessing a major shift from traditional farming to horticulture, meat and poultry and dairy products, all of which are perishables. Due to lack of cold storages in the country, substantial quantities of vegetables and fruits are spoiled. Currently, India has 6300 cold storage facilities unevenly spread across the country, with an installed capacity of 30.11 million metric tonnes. Studies have shown this is half the amount of cold storage facilities that India actually needs (Emerson 2013). The majority of cold chain infrastructure in India was developed in the 1960s, which majorly supported the storage of potatoes and potato seeds. About 75% of the total capacity of cold storages is suitable only for potatoes today as well. Most of these facilities are located in the states of Uttar Pradesh, Uttaranchal, Punjab, Maharashtra, and West Bengal (Renie Subin 2011). Cold storage capacity for all food products in the country should be more than 61 million metric tonnes. In order to reach that target, the report says an investment of more than ₹ 550 billion is needed by 2015-2016 just to keep up with growing fruit and vegetable production levels (Emerson 2013). There are a large number of small players in the Indian cold chain industry existing in unorganised way with low awareness of best storage practices. Some of the well-known companies are Snowman, FHEL, RK Foodland Pvt Ltd and MJ Logistic Services Ltd. It is anticipated that cold chain market in India will get more organised with the entry of large private players in this arena.

*Inadequate marketing network:* Deprived competence

in the marketing channels and insufficient marketing infrastructure are alleged to be the grounds of not only elevated and erratic consumer prices, but also too little of the consumer rupee reaching the farmer (Ashturker and Deole 1985, Kaul 1997). It is important to note that food insecurity is habitually more a question of access (purchasing authority and prices of food) than a supply dilemma. Improving the efficiency of the food supply chain could help to bring down the cost of food to the consumer and thus increase access (FAO 2013). The efficiency of agricultural marketing in India has been of notable concern in the recent years. Indian farmers typically depend heavily on middlemen particularly in fruits and vegetable marketing. The producers and the consumers often get a poor deal and the middlemen control the market, but do not add much value. There is also massive wastage, deterioration in quality, as well as frequent mismatch between demand and supply both spatially and over time (Singh *et al*. 1985, Subbanarasiah 1991). Vertical integration was not observed in Indian marketing system except for small isolated pockets. Market infrastructure was found to be deficient regarding sanitation, with few public toilets, inadequate drainage, and no coordinated pest control. Market integration is crucial from the perspective of food security. Integrated markets for staple foods provide a mechanism for reducing the adverse impacts of imbalance and shocks in demand and supply by allowing food to move quickly from surplus to deficit areas. The increased integration of food markets in developing countries is also considered to be of vital importance for agricultural transformation and economic growth (Fafchamps 1992). In addition, Rashid and Minot (2010) argue that knowledge of spatial market integration can also help better design social safety and hunger reducing programs.

*Impacts of climate change:* Climate on the earth has been changed to many different faces during the existence of our planet (Stern 2007, Miraglia *et al.* 2009, Moretti *et al*. 2010). Climate change will continue to exert its influence not only on crop production, but also on the increasingly valuable harvest produces. Some of the post harvest impacts are an increased rate of crop drying in field and at homestead, increased fire risk of the mature crop, 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. 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 necessaiting 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 and increased risk of reduced seed viability especially for some legumes, e.g. groundnuts (Tanya Stathers *et al.* 2013).

*Lack of scientific extension, access to technologies and interest from farmer side:* Extension and training, about basic understanding of the business aspects as well as the technical implication is vital for farmers to reduce the post harvest loss and increasing the farm income. Unfortunately, the training of extension workers at agricultural colleges does not always deal with the concept of problem analysis. Rather, it focuses on providing farmers with a small selection of officially recommended practices, often derived from research programmes that may not always take into account the different circumstances of the farmers. The recommendations, though technically sound, may be inappropriate, inconvenient or too expensive for some farmers especially small-scale farmers. But farmers are generally in need of information regarding the aspects, like time of harvest, post-harvest techniques (threshing, drying, winnowing: poor handling after harvest may damage grains making them vulnerable to pest attack; delayed or inadequate drying will also encourage mould and insect damage), storage methods, processing methods, marketing and sale, causes and extent of losses and costs and benefits of post-harvest management (Peter Golob 2009). The farmer should be aware of these factors because they influence the length of time the crop can be stored and its ultimate use. The responsibility for providing advice and information to farmers rests ultimately with the field extension workers, whether they are government employees or members of nongovernmental organisations (Sharma *et al*. 2013). The development and adoption of improved agricultural and post harvest technologies play a decisive role in productivity enhancement and welfare of farmers with limited resources (Sall *et al.* 2000). There is wide gap between agricultural technologies produced in research institutions and their adoption by small-scale farmers and rural households (Kroma 2003). This indicates extension need to pay more consideration to conduct farmers training in post-harvest technologies.

The small farmers generally focus on production activities, and show relatively little interest in post harvest and marketing activities which are primarily undertaken by middle men, traders and assemblers. In spite of many success stories, most of the small and poor farmers are not confident about their ability to practice value addition and quality improvement in agricultural produces. Neither they are confident about the appropriateness of the technologies, nor they are convinced about the capabilities of the development agencies involved in launching these projects. Poor farmers lack adequate motivation and training. In this process, many poor farmers have developed a 'dependency syndrome' and expect outsiders to provide the means for their livelihood (Sharma *et al*. 2013).

*Problems in post harvest loss estimate and research to reduce food insecurity in India*

Over the past decades, significant focus and resources

have been allocated to increase food production only. Almost 95% of the research investments during the past 30 years were reported to have focused on increasing productivity and only 5% directed towards reducing losses (Kader and Roller 2004, Kader 2005, WFLO 2010). Our present day research and extension need to be more focussed towards secondary agriculture and reducing the food wastage in each entry of the food supply chain for better nutritious food reach to growing population (Sharma *et al.* 2012, Sharma *et al.* 2013).

Given the significant role of food loss reductions toward sustainably contributing to global food security, it is important to have reliable measures of these losses. Unfortunately, most of the available post harvest loss and food waste estimates are based on the subjective stories with few actual measured or estimated numbers. Moreover these numbers, in turn, feed into estimates of food availability which are widely used in food security assessments and policy analyses (Jaspreet and Anita 2013). Even if the estimates of post harvest loss are done, estimate of quantity lost is projected differently by different organization and agencies. The fact is that the estimate of percentage of wastage in food items by different agency is not having a consensus. So, there is a need of well defined standards for the post-harvest loss estimation.

*Strategies for plummeting post-harvest losses*

Food losses and wastages are grouped in two forms, like quantitative loss and qualitative loss. When product is consumed directly by the producer, quantitative losses cause less food to be available and therefore contribute to food insecurity. Qualitative losses may cause a reduced nutritional status and low quality products may also be unsafe with adverse effects on the health, well being and productivity of the consumer. The lack of decision relevant data (when, where, what, which, how and to whom) has long been a characteristic of post harvest loss and food wastage issues and has been imperative thing to those paying attention in taking battle to trim down post harvest loss. An efficient analysis of each commodity production and handling system is the logical step in identifying a proper strategy for plummeting post-harvest losses and food wastage in developing and developed countries separately.

Significant reductions in food loss can be made by improving farmers' use of good agricultural practices, such as for proper handling of horticulture crops. However, inadequate extension efforts and information from potential buyers limit the degree to which farmers are aware of and actively implementing these practices. Training and education about effective drying, storage practices and marketing strategies are particularly critical in diminishing the food wastage and post harvest losses. Extension need to make unique approaches to transferring knowledge across the value chain on tools and approaches for reducing post-harvest loss.

Reducing post-harvest losses in developing countries requires both public- and private-sector investment in agricultural research, development, and extension, including in appropriate storage technologies and in improved infrastructure to better connect small-holder farmers to local, regional, and international markets. Also, a cost-benefit analysis to determine the return on investment in the recommended post harvest technologies is essential because it is important to select the technologies that are appropriate for the size of each post harvest enterprise by different farmers.

There is an urgent need to create more cold storage facilities to different regions and different commodities. Government in differentially affected countries need to put more emphasis on FDI and capital investment in this regard. There should be an effort to make awareness about all the possible facilities available in the country to reduce post-harvest loss.

Market innovations and market reforms are essential for the food waste reduction campaign. Direct selling markets will create more loyalty among consumers toward the producers and it will create a situation in which producers having more shares on consumer's price. Some of these models are Rythu Bazaar (AP), State Horticulture Corporation Ltd (GOA), VFPCK-Vegetable and Fruits Promotion Council Keralam (KL) and Vegetable Growers Association of India–VGAI (MH). In each of these models, the implementing agency of the respective state government ensures the collection of produce from primary producers along with their post-harvest management, distribution logistics to various points of sales, management of facilities and retail selling prices for consumers. Extension personnel has the responsibility of effective documentation of successful marketing models and disseminate it into different regions with suitable upgradations. Another reform is marketing companies and cooperatives. They are crucial for handling produce and reducing post-harvest losses by providing facilities for accumulating, preparing and transporting produce to markets; by coordinating marketing activities; and by distributing profits equitably to members in regions where less empowered producers and consumers are present.

A common critique of the Indian Public Distribution System is that millions of tonnes of grains are lost in storage due to inadequate facilities. About 194502 metric tonnes of food grain worth crores of rupees was wasted in India due to various reasons between 2005 and March 2013. Many middle men and commission agents are playing in this food storage industry to block the attempts of government to change and improve the efficiency of present system because they benefit from the system that exists now in India. To develop better storage and infrastructure not only the facilities to be improved but also the right policy and economic incentive need to be corruption proof.

New intervention strategies to focus on systemic improvements of the efficiency and sustainability of food chains are needed to be developed. This new approach is embedded within the broader concept of promoting

sustainable food systems like family farming, which also encompasses sustainable food production, on the one hand, and sustainable diets and consumption (such as through the reduction of food waste), on the other. There is a tactical need to intensify these programmes in all the state and needs a concrete action to implement the identified strategies throughout India.

"Food Loss and Waste Protocol", is a global standard for measuring food loss and waste developed by The World Resources Institute (WRI). It will enable countries and companies to measure and monitor the food loss and waste that occur within their boundaries and value chains in a credible, practical, and consistent manner. With the help of collaborative and partnership efforts with available facilities in the world, there is a need to develop well defined standards for the post harvest loss estimation within our nation. Reducing the food wastage and post harvest losses are multi dimensional in nature and needs partnership from all sector like country to country, with in each nation state to state and with in each state public agencies to private agencies etc.

Tapping the potentials and opportunities like diversified agriculture, conservation agriculture, contract farming, and leveraging ICT for beyond production and its replication to potential areas (like Post-harvest Education Foundation, Noida, Uttar Pradesh, in partnership with Amity University and Tamale Polytechnic, is offering post-harvest e-learning programmes open to students and practitioners) are very much important for reducing India's post-harvest loss in context of nutritional and food security to all.

Reducing both post-harvest losses and food waste requires multiple strategies, including increasing consumer awareness, changing consumption behaviour, and refining incentives among supply chain participants in the private sector. The strategies for reducing waste and loss will necessarily be different in developed and developing countries because the underlying causes are different, but curbing waste and loss in both developed and developing countries will yet be critical to reducing hunger and nutritional security in developing countries and meeting future food demand.

It was concluded that prosperity of a nation highly depends on the health of people in that nation. India is often eminent as the most populous democracy in the world, but occupies a mysterious place when it comes to assessing global hunger, with its high rates of deadly malnutrition and its staggering numbers of undernourished people. To sustainably achieve the goals of food security, food availability also needs to be increased through reductions in the post-harvest losses at farm, retail and consumer levels through maintaining proper infrastructure, cold storage and proper dissemination of technologies and market information. 'Hunger free India' status of our nation can be achieved by reaching a stage of 'zero wastage' in agricultural produce through sincere efforts.

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