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RESEARCH ARTICLE

Post-harvest Losses of Vegetables in South Asia

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Introduction

Post-harvest losses negatively impact the economic benefit derived from vegetable production (Weinberger and Acedo, 2011). Vegetables are essential parts of human diets, but they are perishable by nature. Losses between farms and consumers are highest in developing countries where there is a lack of knowledge, skills, technologies, techniques, and facilities for produce handling and processing. This loss of nutritious food and economic opportunities contributes to poverty, unemployment, and malnutrition. This paper analyses the status of post-harvest losses in South Asia, a region with high levels of poverty, malnutrition and food insecurity, and assesses approaches to reducing these losses.

Post-harvest losses

Post-harvest losses vary with crop, location, growing season and the value chain actors involved. The causes of post-harvest losses can start well before harvest in the choice of variety, pest or disease attacks or how the crop was grown. Therefore measures to reduce post-harvest losses should start before harvest. Crops and varieties vary in their degree of perishability, and the growing and harvesting environment and methods used have an impact on losses while the supply and demand situation at harvest time affects the time and distance the produce needs to travel. The social, cultural and economic conditions in a country and those of the main actors in the vegetable value chains also have an impact on their abilities to address losses. In many developing countries, the necessary data is not available to credibly estimate the extent of post-harvest losses (USDS, 2013). In general, loss figures are derived from a single measure (e.g. outright volume loss) or combined with other quantitative measures (weight loss and equivalent volume loss based on price reduction due to reduced quality of still marketable produce). From these figures, global, regional, national and local loss estimates (percentages, volume and monetary value) are derived. Credible loss data at different stages of the value chain is the essential requirement for designing effective interventions to reduce those losses.

Global situation

In 2011, a study commissioned by the Food and Agriculture Organization of the United Nations (FAO) reported that roughly one-third of global food produced for human consumption is lost or wasted, which amounts to about 1.3 billion tons per year worth nearly one trillion US dollars (Gustavsson *et al*., 2011; CGIAR, 2013). Food losses amount to US$ 310 billion annually in developing countries, where nearly 65 per cent of food losses occur at the production and post-harvest stages. In the Asia-Pacific region, between 15-50 per cent of food crop output is lost between the production and marketing stages (FAO, 2014).

Vegetable post-harvest losses vary considerably, with maximum average losses of up to 50 per cent or higher occurring in developing countries (Weinberger and Acedo, 2011). They are a standard feature of supply chains in these countries often typified by hot and humid tropical climates, where there is a lack of knowledge, techniques and facilities in produce handling and processing. Adverse climates and poor management combined with the perishable nature of vegetables have a large impact on reducing the profitability and efficiency of supply chains.

South Asia situation

South Asia comprises of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, and has severe problems of post-harvest losses across many crops that contribute to a high incidence of poverty and food insecurity in the region. The highest losses are in perishable vegetables and fruit, but there is also a lack of reliable data in many situations, with the highest losses often being reported where there is least data available.

Within the region, India is the most advanced in addressing the problem of post-harvest losses and estimating actual losses, and this is a key focus in the country's 12th Five Year Plan (USDS, 2013). India is the world's second largest vegetable producer with an annual production of over 150 million tons growing at a compounded annual rate of 5-6 per cent. (ASSOCHAM, 2013). The All India Coordinated Research Project on Post-harvest Technology conducted a national study to obtain reliable loss estimates for all phases of production and distribution for major crops (Nanda *et al.*, 2012). For vegetables, the total average post-harvest losses were estimated at 7-8 per cent for cabbage, cauliflower and onion, and 13 per cent for tomato. The Associated Chambers of Commerce and Industry of India reported that about 30 per cent of vegetables and fruit are lost after harvest, worth a total of over 2 trillion INR per year (over 33 billion USD) due to lack of storage and processing facilities and indifferent attitudes towards tackling the problem (ASSOCHAM, 2013). Among the states, post-harvest losses are highest in West Bengal (over 136.6 billion INR), followed by Gujarat (114 billion INR), Bihar (107 billion INR) and Uttar Pradesh (103 billion INR). Other authors have also recently estimated loss data (Narayana *et al*., 2014; www.assocham.org; www.crosstree.info/Pages/Links.aspx).

In Bangladesh, post-harvest losses of vegetables were reported to range from 18-44 per cent, equivalent to an average yearly loss of over 2 million tons of produce worth about 3,392 million BDT (45 million USD) (Halim, 2013; Hassan, 2010). In Mymensingh, the highest post-harvest loss was recorded for tomato (37 per cent) followed by okra (34 per cent) and the lowest loss was for pepper (14 per cent) (Hassan, 2010). The causes of losses were improper handling and transportation, poor technologies for storage, processing, and packaging, the involvement of too many market actors, and poor infrastructure including a lack of transport. A recent study in three districts (Barisal, Jessore and Faridpur) found post-harvest losses ranged from 11-33 per cent depending on the crop and value chain actor, with the highest losses found in tomato and by farmers (AVRDC, 2014). The key factors contributing to losses were inappropriate post-harvest technology and insufficient product development services, complex and fragmented marketing systems, lack of appropriate supply chain organization and management, lack of infrastructure such as grading, packing and cool chain facilities, and lack of finance for farmers, traders, wholesalers and retailers for commercial production and marketing.

Nepal produces about 3 million tons of vegetables from an area of 235,100 hectares and post-harvest losses generally range between 25 to 30 per cent (HVAP, 2011). Tomato had the highest losses (33 per cent) followed by cauliflower (14 per cent), cabbage (13 per cent), green peas (10 per cent) and beans (7 per cent). Losses were measured at different stages in the supply chain. For tomato, losses are 10 per cent at the farm gate, 5 per cent at the collection centre, 8 per cent at the wholesale market, and 10 per cent at the retail markets. Losses were due to a lack of proper handling, storage and transportation and in most cases, there is no grading. In the Terai districts of Kapilvastu and Banke, post-harvest losses of tomato and cauliflower were estimated at 25 per cent and 21 per cent, respectively (AVRDC, 2015). Losses borne by tomato farmers, collectors, wholesalers and retailers differed only slightly from each other and were in the range 5-7 per cent, while cauliflower collectors and wholesalers had higher losses than farmers and retailers. Losses borne by farmers were mainly due to pre-harvest insect and disease damage while those borne by collectors, wholesalers and retailers were due to deficiencies in packaging, storage and transportation.

Pakistan produces over 8 million metric tons of vegetables from 611,700 hectares but between 15-40 per cent is lost after harvest (Khokhar, 2014; Pakistan Horticulture Development and Export Board, 2007). The three leading vegetables - potato, onion and tomato - have post-harvest losses of 15 per cent, 20 per cent and 40 per cent, valued at about 582, 579, and 341 million PKR or

EDITORIAL

Dear Palawija News readers,

The United Nations Food and Agriculture Organization (FAO) estimates that globally, about one billion people go hungry every day, while a third of the food produced goes to waste. The reduction of food losses and waste is thus of critical importance to feed the world sustainably.

A global multi-stakeholder initiative 'The Food Loss and Waste Protocol' is taking shape to develop the global accounting and reporting standard for quantifying food and associated inedible parts removed from the food supply chain. It is a collaboration between the World Resources Institute, the World Business Council for Sustainable Development, FAO, United Nations Environment Programme and other partners. In Asia and the Pacific, a regional multi-stakeholder consultation on food loss and food waste was also convened by FAO in July 2015 to share experiences and discuss the way forward to accelerate concrete and practical actions in reducing food losses and waste in the region.

The current issue of Palawija Newsletter highlights this important topic, action on which is in the interests of all of us.

The first article by Antonio Acedo Jr. and Warwick Easdown of AVRDC - The World Vegetable Center, analyses the status of post-harvest losses in South Asia, a region with high levels of poverty, malnutrition and food insecurity, and assess approaches to reducing these losses.

The second article by I Made S. Utama and Lisa Kitinoja highlights the post-harvest vegetable losses in small-scale agribusiness chains in Bali, Indonesia. The article notes the importance of promoting value chain partnership programmes to improve the efficiency and effectiveness of the agribusiness chain systems.

This issue reviews a report by the University of Nottingham titled *The Impact of Reducing Food Loss in the Global Cold Chain*, which focuses on perishable food losses, from harvest or slaughter through to retail. Links to additional recommended readings are provided. A story that highlights the scope for innovative technologies to reduce post-harvest losses in the case of South Asian mangoes is also presented in this issue.

We hope readers will benefit from the articles and information presented in the newsletter and we welcome your feedback and contributions for future issues of the newsletter.

58, 58 and 34 million USD, respectively. Post-harvest losses for other vegetables averaged 30 per cent, worth 2,161 million PKR (216 million USD). The causes of loss include a lack of roads for linking farmers to markets, a lack of packing and grading facilities in the production areas, poor grading and packing procedures to meet market requirements, and a lack of refrigerated transport.

In Afghanistan, post-harvest losses of vegetables and fruit were reported at 50-60 per cent of total production (Soofizada, 2014; USDS, 2013). The main causes of the losses include a lack of farmers' knowledge of good post-harvest practices (proper handling, packing, sorting, grading, cooling, observing quality standards and food safety, processing, and marketing), poor extension services, communication and coordination, inadequate cold storage, refrigerated truck and packing house facilities, inadequate processing facilities, poor transportation, and high transportation cost.

In Bhutan, post-harvest losses of the major vegetables were reported to range from 16-22 per cent for potato, 15-20 per cent for cabbage, 22-25 per cent for tomato, 20-22 per cent for beans, 30-35 per cent for peas and 15-18 per cent for cauliflower and broccoli (Thinley, 2014). These losses were mainly due to inadequate handling, packaging, transport and storage practices resulting in physical damage and spoilage of the produce.

In Sri Lanka, about 16-40 per cent of the total production of vegetables (565,250 metric tons

from an area of 110,960 ha) is wasted after harvest (Bamunuarachchi *et al*., undated; Warushamana, 2011). Poor packaging and transportation were the leading causes along with a lack of proper storage.

Losses in nutritional quality

Unseen losses relating to loss of nutritional value (e.g. loss of vitamins) are not reflected in the loss figures above. Vegetables are essential to balanced diets, being rich in vitamins, minerals, dietary fiber and phytochemicals whose retention from farm to table should be maximized (Acedo *et al*., 2014; Terry, 2011). Some losses are inevitable, but better understanding of the possible causes can help to find measures to diminish such losses. Some nutrients begin to decrease after harvest and continue to decline until the produce is eaten, and so the sooner fresh produce is eaten, the less the nutrient loss.

Ascorbic acid (vitamin C) is often used as an index of nutritional quality loss because it is susceptible to loss after harvest and during storage, processing and cooking as it is water soluble and sensitive to heat, light, and oxygen (Barrett, 2007). Vitamin C losses depend on the crop and the conditions before and after harvest, and can range from 27-100 per cent after 7 days at 20°C (Rickman *et al*., 2007a). Losses in B vitamins also occur during transportation and storage of fresh vegetables. In particular, thiamin and vitamin B6 are quite sensitive to heat and light and losses in various vegetables may range from 7-70 per cent with canning and 20-60 per cent with blanching and freezing. Polyphenolics generally decline with the storage of fresh vegetables and as a result of canning and blanching, while mineral and fiber contents, being relatively inert and not sensitive to the thermal processes used in food preservation and preparation, have been found to be at similar levels in fresh, canned, and frozen vegetable products. Fat-soluble nutrients such as vitamins A and E and the carotenoids (including lycopene) are sensitive to heat, light, oxygen, and pH. However, because these compounds are fat-soluble, there is little leaching into cooking water or the canning medium (Rickman *et al*., 2007b). Compared to the water-soluble vitamins, the carotenoids are relatively stable during processing, storage, and cooking. Traditional sun-drying, although the cheapest and most accessible means of food preservation in developing countries, causes considerable destruction of nutrients and bioactive compounds, particularly during storage of the dried product because of the greater surface area of the dried product exposed to oxygen and light compared to the fresh produce. Drying in even a simple and inexpensive solar dryer can appreciably reduce nutrient losses. Protecting the food from direct sunlight during storage also has a positive effect. In the last two decades, non-thermal processing technologies (e.g. high pressure processing, high-intensity pulsed electric field processing) have been introduced to inactivate microorganisms and enzymes, without adverse effects on sensory and nutritional properties. These technologies can be adapted to South Asia.

Table 1 shows the typical nutrient losses from different processing operations. However, this information is only intended to serve as a guide because several factors can influence nutrient losses, such as type of produce, location, and growing and processing conditions.

Table 1. Typical maximum nutrient losses as compared to fresh produce

Compounds	Freeze	Dry	Cook	Cook+Drain	Reheat
	(in percentage - %)				
Vitamins					
Vitamin A	5	50	25	35	10
Retinol Activity Equivalent	5	50	25	35	10
Alpha Carotene	5	50	25	35	10
Beta Carotene	5	50	25	35	10
Beta Cryptoxanthin	5	50	25	35	10
Lycopene	5	50	25	35	10
Lutein+Zeaxanthin	5	50	25	35	10
Vitamin C	30	80	50	75	50
Thiamin	5	30	55	70	40
Riboflavin	0	10	25	45	5
Niacin	0	10	40	55	5
Vitamin B6	0	10	50	65	45
Folate	5	50	70	75	30
Food Folate	5	50	70	75	30
Folic Acid	5	50	70	75	30
Vitamin B12	0	0	45	50	45

Compounds	Freeze	Dry	Cook	Cook+Drain	Reheat
	(in percentage - %)				
Minerals					
Calcium	5	0	20	25	0
Iron	0	0	35	40	0
Magnesium	0	0	25	40	0
Phosphorus	0	0	25	35	0
Potassium	10	0	30	70	0
Sodium	0	0	25	55	0
Zinc	0	0	25	25	0
Copper	10	0	40	45	0

Source: http://nutritiondata.self.com/topics/processing#ixzz3aaSAgR6R

Reducing post-harvest losses

The 'Save Food: Global Initiative on Food Loss and Waste Reduction' launched by FAO and its partners in 2011 ignited renewed interest in food loss reduction (FAO, 2012). A similar FAO initiative was pursued in 1975 but over the next three decades over 95 per cent of donor support to increase food availability went in increasing crop production rather than in reducing post-harvest losses (Kader and Rolle, 2004).

The global loss reduction initiative was backed by various development groups including the World Bank (2014), CGIAR (2013) and USAID and provided the impetus for regional initiatives such as the Save Food Asia-Pacific (FAO, 2014). Today, two thirds of the world's 870 million hungry and malnourished people are in South and South-East Asia (FAO, 2010). There is a need to feed an additional two billion people by 2050 (FAO, 2011), and governments are well aware of the social unrest associated with food price increases. It has been estimated that half of the current post-harvest losses can be prevented with a more efficient supply chain and the saved food can feed about one billion extra people.

Many targeted approaches can be used to reduce food loss and waste. Practical and cost-effective approaches that could be implemented quickly, and that could achieve quick gains include using evaporative coolers in places where refrigeration is unavailable, introducing hermetically sealed plastic storage bags, using plastic crates instead of bags, changing food date labels to reduce consumer confusion about when food is unsafe, conducting consumer awareness campaigns and facilitating food redistribution (Lipinski *et al*., 2013). Several cross-cutting strategies such as the ones below are needed and require action from multilateral and bilateral donors, intergovernmental agencies, national governments, and the private sector:

1. Developing a food loss and waste measurement protocol.
2. Setting food loss and waste reduction targets.
3. Increasing investment for reducing post-harvest losses in developing countries.
4. Creating entities devoted to reducing food waste in developed countries.
5. Accelerating and supporting collaborative initiatives to reduce food loss and waste.

Reducing post-harvest losses through appropriate post-harvest technologies has far-reaching benefits. As developing countries integrate into the world economy, the implementation of post-harvest technologies can enable these countries to improve the quality of their agricultural produce in domestic and international markets at competitive price.

Conclusion

The benefits of adopting post-harvest technologies to reduce losses are high. Addressing the post-harvest problems that characterize the vegetable sector in developing countries, including South Asia, provides significant scope to increase food supplies and to improve the well-being of millions of poor farm households, and it is a key aspect of the work of AVRDC – The World Vegetable Center.

(List of references can be made available upon request)

SHORT ARTICLE

Post-harvest Vegetable Losses in Small-scale Agribusiness Chains of Bali, Indonesia

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Introduction

Bali is a small island with an area of about 636.66 km^2. It is also one of the provinces in Indonesia and is a well-known world tourist destination. Bedugul is a mountainous region (1,300 m) located in the middle of the island of Bali with three lakes (Lakes Beratan, Buyan and Tamblingan) and having cool temperatures (18-25°C), which makes this region the centre of vegetable production for the needs of the people of Bali and foreign tourists. More than 100 kinds of vegetables and herbs are grown in this area in response to the needs of the tourism industry.

The cultivation of vegetables in Bedugul is performed by small-scale family farmers with land area ranging from 0.25-0.50 ha. This horticultural cultivation is the main business activity providing family income. Family farmers generally cultivate more than one plant species (multiple cropping), so that if one species gets a very low price, the cost of its production can be covered from the price obtained for the other species. The farmers are very flexible and can choose between alternative high value species and varieties of vegetables or herbs in accordance with market demand, based on their interaction with actors in the upper distribution chains. Small-scale cultivation is carried out with the intensive involvement of family members using a simple technology that has evolved in response to market needs. Closed cultivation in greenhouses with simple construction using bamboo or wood and plastic Ultraviolet (UV) resistant roofing to regulate the penetration of sunlight has also emerged. End markets of the vegetables and herbs vary widely, and include traditional village markets, urban traditional markets, modern supermarkets, institutional consumers (hotels, restaurants and catering services) and small markets such as incidental Sunday organic markets in the tourist area of Ubud and Sanur. The volume of organic products for the purpose of this small weekly market is insignificant compared to the total production which is mostly non-organic.

Vegetable distribution channels

There are five significant distribution channels for fresh vegetables and herbs from the region of Bedugul with different chain lengths (Figure 1).

Figure 1. Distribution channels and losses of vegetables produced in the area of Bedugul, Bali

Channel	Loss				Total Loss
1	5-10% Farmers	5-10% Local Traditional Retail Market			10-20%
2	5-10% Farmers	0-5% Local Collectors	0-2% City Collectors	10-15% City Traditional Retail Markets	15-32%
3	5-10% Farmers	8-15% Sub-District Wholesale Traditional Market	0-2% City Collectors	10-15% City Traditional Retail Markets	23-42%
4	5-10% Farmers	2.5-5% Suppliers of Modern Market	10% Modern Markets		17.5-25%
5	5-10% Farmers	2.5-5% Suppliers of Institutional Consumer	2-3% Institutional Consumers		9.5-18%

About 75 per cent of the production flows in the first, second and third channels, and the remaining 25 per cent in the fourth and fifth channels. Based on a value chain orientation assessment conducted in 2013 using eight criteria (Collins, 2009; DFID & SDC, 2008), namely the balance between price and value, amount and type of information shared, time orientation, the nature of relationships, interactions between chain members, dependence in the chain, power in the chain, and orientation of chain members, the first to third distribution channels showed very weak value orientation. While the fourth and fifth channels were found to be already value-oriented, they were still in need of strengthening of the value chains in accordance with increasing market sophistication, especially with regard to the intrinsic and extrinsic qualities assessed (namely, compliance with quality and food safety assurance, and environmentally friendly production). Table 1 provides a list of the characteristics associated with different types of end markets. While some international hotels in Bali require certification of quality assurance and food safety as well as environment-friendly production, this cannot be fulfilled by the existing agribusiness system for vegetables in Bali which indicates that the system has not been effective in taking advantage of the opportunities offered by the dynamic market.

traditional retail markets (10-15 per cent) that involve longer travel from the farm. It seems that consumer quality preferences in the urban areas are higher than for consumers in the villages, so the waste in the city traditional retail markets is more than in the local traditional retail markets. The loss is relatively lower at the local collectors' level as the vegetables are quickly distributed to city collectors who come directly to the village. The maximum delay in distribution of the fresh products from local to city collectors is only one night.

The first, second and third distribution channels are all subject to weight deduction. For instance, a weight deduction is applied to the farmers' produce when the transaction occurs at the local collectors' level. The reason is to compensate for the known risk of damage and losses during handling and transport. Weight deductions vary from about 5-10 per cent depending on the perishability of different vegetables. The same weight deduction is also applied when the farmers make transactions at local traditional retail markets or at the sub-district wholesale market to compensate for future losses.

In the fourth and fifth distribution channels, which are for more value-oriented markets/consumers, the farmers bring their products in accordance with established grades and volumes demanded

Table 1. Quality consideration and market sophistication of different types of end markets for fresh vegetables and herbs in Bali

Types of Markets	Characteristics of Market Demands
Traditional market	Affordability and price are dominant
Modern markets, international hotels, restaurants and catering services	Intrinsic quality is dominant
Some international hotels and restaurants	Intrinsic and extrinsic quality factors

Product loss

The level of product loss depends on the agribusiness chain system or distribution channel. In general, the loss of production on farm as rejected or non-harvested vegetables is about 5-10 per cent due to the production size not being in accordance with market demand, and defects due to pest attack or diseases. The percentage of loss at the production stage can be greater depending on the level of pests and disease attack during the production process. The loss in the local traditional retail market located close to the production area (within 15-30 minutes travel time) occurs due to mechanical, physiological, and micro-biological damages during marketing. The damage ranges from 5-10 per cent which is lower than the damage that occurs in case of city

by the suppliers of modern markets and/or institutional consumers. Weight deduction is not applied.

The loss of produce for suppliers is 2.5-5 per cent, which occurs due to trimming of the produce received from partner farmers. Suppliers are generally located near the site of production and transport supplies of the produce to the modern markets and/or institutional consumers in the early morning (5 a.m.) when air temperature is low. Transportation is through small pickup vehicles and the number of vehicles owned by a supplier varies depending on the number of modern markets and/or institutional buyers he/she serves. Normally, suppliers set their arrival time at the modern markets before 8 a.m., while

for institutional customers it is set at no later than 9 a.m. Some suppliers use refrigerated pickup vehicles for traveling up until 9 a.m. As part of added services, especially for institutional buyers who need incidental or irregular supplies of vegetables beyond the typical morning arrival time, one of the suppliers had established a cold storage facility in the city of Denpasar.
The quantity stored was limited to a maximum of 5 per cent of the total produce supplied per day to the supplier's institutional customers.

There is a distribution centre managed by Tiara Group Supermarkets which prepares retail units or consumer packages of many types of fresh produce for four Tiara Dewata Supermarkets located in different parts of the city of Denpasar. Suppliers bring produce to the centre in large bulk plastic crates in the morning by no later than 8 a.m. The fresh produce is then washed, trimmed and stored temporarily at 2-5°C before being prepared as consumer packs. The centre also provides cold rooms at different temperatures to store various types of fruit, vegetables and herbs. Losses of more than 10 per cent occur during retail preparation, storage and retail at the supermarkets. The losses are tracked and charged to the suppliers as 'return products'.

For other supermarkets that do not have a distribution centre, the preparation of produce for retail is generally carried out by suppliers in their own packing houses. A multinational supermarket in Denpasar charges the suppliers 8.3 per cent of the total fresh produce for offering regular discount (3.5 per cent) and tax rebates (1 per cent) on the products, promotion budget (1.5 per cent), anniversary support (1 per cent), Eid support (1 per cent) and packaging cost (0.3 per cent). The losses that occur at the level of institutional customers are much smaller, ranging from 2-3 per cent. The institutional customers normally order the fresh produce on a daily basis as required.

Conclusion

The losses at each level in the distribution channels are a financial burden on farmers and impact the farm gate price. The burden increases when farmers are involved in distribution channels first to third since an automatic weight deduction of 10 per cent is applied at local traditional retail markets, subdistrict wholesale market and by local collectors. For distribution channels fourth and fifth, which are oriented towards value with long-term cooperation between chains, the loss is lower. In addition, other benefits obtained from those value chains (in channels fourth and fifth) include the following: the farmer's cropping pattern can be planned/ controlled, there is certainty in sales and there is certainty in price based on monthly contracts between suppliers and modern markets and/or institutional buyers.

Based on the level of losses, which are typically 30-40 per cent but can sometimes reach as high as 75 per cent of production for channels first to third, small-scale agribusiness chain systems for vegetable marketing from the production area of Bedugul are not very efficient or effective, especially in terms of value creation and responding to dynamic markets/consumers. Similarly, in distribution channels fourth and fifth, despite being value oriented, the value chains still need to be strengthened, mainly with regard to the control system for value creation along the whole chain as well as in terms of internal control within each chain. Such strengthening is important for responding to dynamic consumer preferences or differing cultural values of consumers in the tourist island of Bali. The losses during production also need to be given serious attention because the proportion of unmarketable produce is still high. This produce is left on the farms to be composted, or sold at a lower price via channels first to third after being rejected by the suppliers for channels fourth and fifth. Therefore, in order to improve the efficiency and effectiveness of the agribusiness chain systems for vegetables grown in the production area of Bedugul, Udayana University through the Udayana Community Development Program (UCDP) and the Center for Research and Development on Horticultural Crops (CREDHOC) has been supporting and promoting value chain partnership programmes.

(List of references can be made available upon request)

The Impact of Reducing Food Loss in the Global Cold Chain

BOOK REVIEW

C. G. Winkworth-Smith, T. J. Foster and W. Morgan,
University of Nottingham, March 2015.

A third of all food produced globally is lost or wasted. Given the many starving people and poor levels of nutrition around the world, reducing this waste would appear to be a key global priority. By 2050, the global population will reach 9 billion. If current levels of food loss and waste are maintained, food production will need to increase by as much as 70 per cent in developing countries alone, requiring investment of $83 billion a year.

Reducing the levels of loss and waste will have a large impact on food security, nutrition, rural income and the environment. Dealing with hunger though is not just a matter of increasing availability of calories; increased availability for consumption of micronutrients is also important to combat hidden hunger. This can be addressed through loss reduction targeted at key food groups such as fruit and vegetables.

This report focuses on perishable food loss, from harvest or slaughter through to retail. The findings draw on a literature review but more centrally from a survey of a number of experts from different geographical regions and areas of expertise to enable the writers to produce a more accurate picture of where food is lost in the supply chain and what measures can be implemented to reduce this loss.

The cold chain is the uninterrupted temperature controlled transport and storage system of perishable goods between producers and consumers. Only about 10 per cent of perishable foods are refrigerated worldwide, yet refrigeration is the best technology, with no associated risks, to ensure food safety and prolong the shelf life of perishable food.

To reflect the fact that reducing loss is not simply about increasing calorie intake, the report focuses on the fresh fruit and vegetable sector. The level of potential improvement in micronutrient levels arising from reduction in loss in this sector is significantly higher than in grains and cereals and also would benefit more squarely from cold chain technologies in helping this goal to be achieved. Further, through the use of case studies the report highlights how solutions vary across the globe and along supply chains.

Source:
http://naturalleader.com/wp-content/themes/natlead/images/UTC%20Nottingham%20Report_3-30_FINAL.PDF

Other reading and resources:

Food losses and waste in the context of sustainable food systems
Policy Brief, SIANI (Swedish International Agricultural Network Initiative), June 2015
http://www.siani.se/sites/clients.codepositive.com/files/document/siani_policy_brief_flw_hlpe_june_23_web.pdf

Appropriate food packaging solutions for developing countries - new edition
FAO, 2014
http://www.fao.org/docrep/015/mb061e/mb061e00.pdf

Reducing food loss and waste
Creating a sustainable food future, installment two
Brian Lipinski, Craig Hanson, Richard Waite, Tim Searchinger, James Lomax and Lisa Kitinoja.
World Resources Institute (WRI), June 2013
http://www.wri.org/publication/reducing-food-loss-and-waste

NEWS AND ACTIVITIES

Inception Workshop and Orientation Meeting for Myanmar Dry Zone project

CAPSA in partnership with the Asian and Pacific Centre for Transfer of Technology (APCTT), the Centre for Sustainable Agricultural Mechanization (CSAM) and the Network Activities Group (NAG - a Myanmar-based NGO) organized an **Inception Workshop** of the project titled 'An Integrated Economic and Social Development Programme for Livelihoods Improvement in the Dry Zone of Myanmar' on 5 May, 2015 in Yangon, Myanmar.

The project is funded through the Livelihood and Food Security Trust Fund (LIFT) managed by the United Nations Office of Project Services (UNOPS) and aims to support integrated socioeconomic development in Myanmar's Dry Zone in the context of inclusive and sustainable development with special emphasis on livelihoods improvement and food security.

The overall objective of the Workshop was to facilitate mutual understanding on the project and other ongoing and planned activities, and to identify opportunities for collaboration. Around 30 participants including representatives of LIFT development partners working in the Dry Zone, government ministries, international aid agencies, NGOs and local civil society organizations participated in the workshop. A number of key priorities for sustainable agriculture and rural development in the Dry Zone were identified through a participatory process, which will guide the project's work in the coming months.

The project will undertake a number of analytical and capacity-building activities including development of case studies relating to policy analysis and stakeholder mapping in three thematic areas, namely value chains for seed development, poverty reduction through sustainable agriculture, and agricultural machinery. To facilitate the development of the case studies, an **Orientation Meeting** for technical experts engaged by CAPSA, APCTT and CSAM was held in Yangon on Thursday, 27 August 2015 at the Central Department of Small and Medium Enterprises Development, Ministry of Industry.

The Orientation Meeting introduced the experts to the project and enabled a common understanding of the methodology for development of the case studies. The meeting also brainstormed on initial ideas outlining each case study.

Revamped SATNET website (www.satnetasia.org)

CAPSA has developed a revamped portal for the 'Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and South-East Asia' (SATNET Asia Network) to facilitate enhanced online interaction and networking amongst a range of government and civil society stakeholders in sustainable agriculture in the region. The portal offers the latest news from network participants, a wealth of knowledge resources, and a database on sustainable agricultural technologies.

The website has also incorporated an electronic discussion platform called the SATNET Social Hub that allows registered users to ask questions, discuss issues and share technical files and photos with one another. CAPSA invites users to visit the revamped website and create a profile that will enable them to participate in various discussion groups and comment on any articles posted on the website.

SATNET Asia Capacity-Building Materials

CAPSA has finalized capacity-building materials developed under the framework of the SATNET Asia project. Hard and soft copies of trainings manuals, agriculture technology fact sheets and policy briefs were disseminated to SATNET Asia participants for their use and further distribution within their own networks.

Three training manuals on the following themes have been published in English language: Integrated Pest Management (IPM); Post-harvest, Trade and Marketing; and Project Development and Management for Sustainable Agriculture. Two of the manuals, namely on IPM and Post-harvest, Trade and Marketing, have also been translated into Bangla and Khmer languages for broader outreach and better utilization at the national and subnational levels.

In addition, 17 fact sheets on sustainable agricultural technologies and good agricultural practices developed through SATNET's analytical work have been translated and published in three languages, namely Bangla, Hindi and Khmer. The translated versions are expected to enhance the reach of these knowledge resources in Bangladesh, India and Cambodia, particularly for field level change agents.

To download the above-mentioned materials, please visit:
http://www.satnetasia.org/publications.

SUCCESS STORY

Reducing Post-harvest Losses in Mango in South Asia

Despite several strategies being adopted to minimize post-harvest losses in India and Sri Lanka, success at the farm level is limited due to the small and marginal nature of farm holdings, inconsistent post-harvest management practices, and poor infrastructure including cold storage facilities.

In Canada, scientists at the University of Guelph have developed a biochemical formulation that is an artificially synthesized version of hexanal (a substance naturally produced by injured plants) which delays ripening of temperate fruits (Sharma *et al.*, 2010). In 2013, the Guelph team, together with partners from the Tamil Nadu Agricultural University (TNAU) in India, and the Industrial Technology Institute (ITI), Sri Lanka, successfully demonstrated this technology on a tropical fruit - South Asian mangoes.

The work has included an extensive study of the biosafety of hexanal with data clearly showing that hexanal is harmless to honey bees, natural pest enemies and earthworms. A study of how hexanal interacts with human cells, such as lung and skin cells, also found no harmful effects.

Work has since been carried out to develop packaging material containing hexanal, which can be slowly released during transportation and storage in order to maintain fruit condition. MYRADA, an NGO, has helped to disseminate the new technologies, by supporting the formation of 45 mango producers groups, comprising 750 mango growers in Tamil Nadu state of India (with over 60 per cent being women) and 139 mango growers in Sri Lanka (over 20 per cent being women).

Treatment with hexanal more than doubles mangoes' shelf life (up to 17 days at room temperature and 26 days in cold storage conditions). Such shelf life extension can help in long distance transport and price stabilization.

In field tests conducted in three major mango growing areas in Tamil Nadu, spraying mangoes with a very low concentration of hexanal (0.02 per cent) twice during the growing season was found to retain the fruit on the tree for an extra three weeks, compared to non-sprayed mangoes. Delaying the harvest enabled farmers to get a premium price in the market - nearly double what was paid three weeks earlier. This has helped to promote nutritional security for women and children.

Through training, group meetings and field level interactions, the adoption of good agricultural and farm management practices by the mango growers has increased by 22 per cent. Post-harvest losses of mango at the field level have come down by 10 per cent (700-900 kg/ha) through the adoption of appropriate harvesting and post-harvest practices, including use of suitable harvesting tools, and techniques of fruit collection, cleaning, grading, sorting, packaging and transport. Reduction of post-harvest losses has resulted in the greater availability of quality fruits in the market, thereby generating an additional income of INR 5,600 (US$92) per hectare per year.

Source:
Stories of change: Reducing post-harvest losses in mango in South Asia
By KS Subramanian, C Sekar, S Suranee Meneka and L Vijaya Prakash
http://www.idrc.ca/EN/Documents/Reducing-post-harvest-losses-in-mango-in-South-Asia.pdf

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