Feasibility of a network of excellence postharvest food losses

Combining knowledge and competences to reduce food losses in developing and emerging economies

Bart van Gogh
Lusine Aramyan
Addie van der Sluis
Han Soethoudt
Frans-Peter Scheer

Report 1402

Colophon

This study was conducted by Wageningen UR Food & Biobased Research in co-operation with LEI Wageningen UR, by order of the Ministry of Economic Affairs in the Netherlands, department of European Agricultural Policy and Food Security.

Title	Feasibility of a network of excellence postharvest food losses
Author(s)	ir. J.B. van Gogh, dr. L.H. Aramyan MSc., dr.ir. A.A. van der Sluis, dr.ir. J.M. Soethoudt, ir. F.P. Scheer
Number	Food & Biobased Research 1402
ISBN-number	978-94-6173-693-2
Date of publication	1 May 2013
Confidentiality	No
Approved by	ir. J.E. de Kramer

Wageningen UR Food & Biobased Research
P.O. Box 17
NL-6700 AA Wageningen
Tel: +31 (0)317 480 084
E-mail: info.fbr@wur.nl
Internet: www.wur.nl

Acknowledgements

This study on the feasibility of a virtual network of excellence with a focus on reducing post-harvest food losses, was initiated and supported by the Dutch Ministry of Economic Affairs. The project team surveyed scientific publications and reports from institutions (governmental and non-governmental) involved in the international food security debate. The review was used to articulate findings on the feasibility of establishing a network of stakeholders that will have an impact on the reduction of food losses thereby supporting food security. Stakeholder parties in the Netherlands were interviewed to collect opinions on how to formulate actions that can contribute to lowering food losses in supply chains. Furthermore, their interest in participating in such a network was assessed. In a workshop results were shared and discussed with interested stakeholder parties. The authors wish to express their gratitude to all persons who have been involved in this process, for their input and feedback on the concept and ideas.

Summary

Motivation: food security & postharvest losses
Fruits and vegetables supply chains in developing countries are characterised by relatively high losses between harvest and consumption. In general, the postharvest system includes all stages in the chain where the activity/service is intended to add value to the final product. Postharvest loss is often used to describe "losses between harvest and the onward supply of produce to markets and equates broadly with waste in the food supply chain". In the Food Loss Reduction Strategy, FAO stated that losses for perishable crops, by their nature, are higher than those for cereals, and vary highly by region and commodity type. Losses over 50% are suggested.

Intervention: Network of Excellence postharvest losses
For a sustainable reduction of postharvest food losses, an intervention has to be planned within the context of the relevant value chains. The idea that a conglomerate of stakeholders, rather than a single party, would engage more effectively with the complexity of causes of postharvest losses is the basis for the establishment of a Network of Excellence (NoE). Such a network will also encourage co-operation between the private and public sector, as well as knowledge institutes. In the Netherlands, network experiences are already gained from the co-operation between government, research institutes and the private sector (the Golden Triangle). This may serve as an example for an international level, in order to disclose unique and viable knowledge which in past en present has been key in securing food and nutrition in the Netherlands.

Analysis: causes of postharvest losses in the FSC of fruit and vegetables
The research has the objective to gain insight into the causes of postharvest losses in fruit and vegetable supply chains in developing economies, and on which areas of expertise the network should focus. The report contains a qualitative survey of available literature and project documentation, reviewing references from scientific and project databases on the subject of postharvest food losses and their causes in developing countries. In addition, different stakeholders as well as agricultural representations at the Dutch embassies, were invited to express their experiences and insight in postharvest losses in the developing economies where they are active. This combined has resulted in an overview of causes by category, that have been weighted by the number of references in the different sources. The top-3 causes comprises the categories cold chains/refrigerated transport, storage facilities and product handling, and accounts for more than 40 percent of the identified causes of loss in the postharvest chain.

Network of Excellence: conditions
To assess the feasibility of setting up a NoE, a variety of stakeholders was interviewed with the purpose to retrieve their view and interest. The network will facilitate stakeholders to combine efforts in designing and implementing solutions to reduce postharvest losses. In the process of developing and implementing practical and appropriate solutions, the private sector has a role to play, as well as knowledge institutes, NGOs, intermediary organisations and public agencies, in

order to tackle the mentioned complexity of postharvest losses. An overall interest exists in the idea of developing a dedicated NoE. With respect to the success of a NoE, stakeholders referred (amongst others) to the long term perspective for developing - and financing of the network organisation and activities. In the opinion of some of the stakeholders the network's added value will be the ability to obtain clear defined postharvest questions from the target groups, as well as the ability to generate impact on local chains in terms of reduced losses.

Network of Excellence: opportunities

Postharvest knowledge and its transfer to the identified target groups is key within the context of the NoE. From the interviews, as well as from the workshop that was summoned on the subject of the feasibility of the NoE, the opinion was retrieved that such a network has the potential to internationally position Dutch expertise and knowhow in this field. The NoE would disclose knowledge on postharvest related issues to the network's target groups, as well as between network members themselves. Branding of the network by its 'excellence' would imply the selection of network members by their excellence in their respective fields of expertise. Whether this would in- or exclude also foreign entities is a matter for debate during the process of formation of the NoE. By performing an intermediary role as matchmaker between network members and network clients, the NoE will disclose this knowledge to chain actors in developing countries. The prominent posting of Dutch knowledge on postharvest issues, can yield benefits for all members that provide their respective expertise and networks in a precompetitive phase in the NoE.

Content

Overview of figures & tables in this report:

1 Introduction

1.1. Project context

The Dutch Ministry of Economic Affairs has requested Wageningen UR Food & Biobased Research (FBR) to assess the feasibility of establishing a network to develop agrologistics-based solutions for the reduction of postharvest food losses in developing and emerging economies. The motive for this study lies in the occurrence of high losses in the supply chains for food products worldwide, and for the low income and emerging countries in the postharvest chain in particular. The focus on 'post-harvest food losses' stems from the international debate on food security and sustainable food production.

Figure 1 The Golden Triangle - driving force for agro-innovation in the Netherlands

Fresh supply chains in developing countries are characterised by relatively high losses that take place in all the steps and processes between harvest and consumption. In FAO's Food Loss Reduction Strategy it is stated that perishable crops losses, by their nature, are higher than those for cereals and vary highly by region and commodity type, suggesting losses over 50% (1). Although data on postharvest losses in low income countries are scarce and difficult to verify, consensus exists among postharvest experts that losses are relatively high. Also in emerging markets substantial losses occur as a result of rejection and product spoilage in the fresh chain, before products reach the markets. The relatively high losses (percentage-wise, volume-wise, finance-wise and energy-wise) and the growing importance of fruits and vegetables in local and

global supply chains, was reason to place the primary focus of the study on fresh vegetables and fruits. The scope of the study may, however, apply to other food perishables as well.

For a sustainable approach to postharvest food loss reduction, an intervention has to be planned within the context of the relevant value chain. More than one type of intervention may be required. The starting presupposition for a network approach is that the Netherlands have a technologically sophisticated and efficiently organised network for the production and distribution of vegetables and fruits, making the country one of the world's main producing and trading nations. Food losses have a negative impact on food security in low income countries, as well as on the sustainable development of food production systems in emerging countries. A network of stakeholders in Dutch agribusiness provides the opportunity to develop and export holistic solutions that will tackle the complexity of supply chain logistics in a developing environment.

The Ministry of Economic Affairs advocates that the Dutch corporate sector in conjunction with knowledge centres and non-governmental organisations will stand at the helm of creating and implementing sustainable solutions for reducing postharvest food losses. Through encouragement of forming a dedicated Network of Excellence for the reduction of postharvest food losses, the Ministry intends to support a successful method of co-operation between different stakeholders. The network approach is based on the idea that a conglomerate of stakeholders, rather than a single party, would engage with the before-mentioned complexity more effectively. In this way *on occasion* partnerships between private parties within the network can enable the integration of the several aspects that are involved in postharvest chain-based solutions. The network may also encourage co-operation between the private and public sector, as well as knowledge institutes, when investments in the public and private sphere are complementary and vital. Dutch network experiences gained from the co-operation between government, research institutes and the private sector within the Golden Triangle may serve as an example on an international level to disclose unique and viable knowledge on a case-by-case basis. The Dutch Golden Triangle refers to the successful partnership between government, the private sector and knowledge institutes in agricultural development. This has been a key in securing food and nutrition in the Netherlands. The model points to the importance of making partnerships work for innovation and development (26).

1.2. Purpose of the research

The purpose of the research is to establish the feasibility of the development of a virtual network of excellence that will be dedicated to reducing postharvest food losses in countries where food security[1)] is under pressure. For this the study intends to gain insight in:

- the causes of postharvest food losses in developing and emerging economies

1) The term food security refers to the availability, affordability and accessibility of food.

- the fields of expertise that (based on these causes) can be identified as relevant for the network
- the stakeholders in the network and their complementary roles
- stakeholders interest to participate in such a network

Within this context stakeholders are identified as:

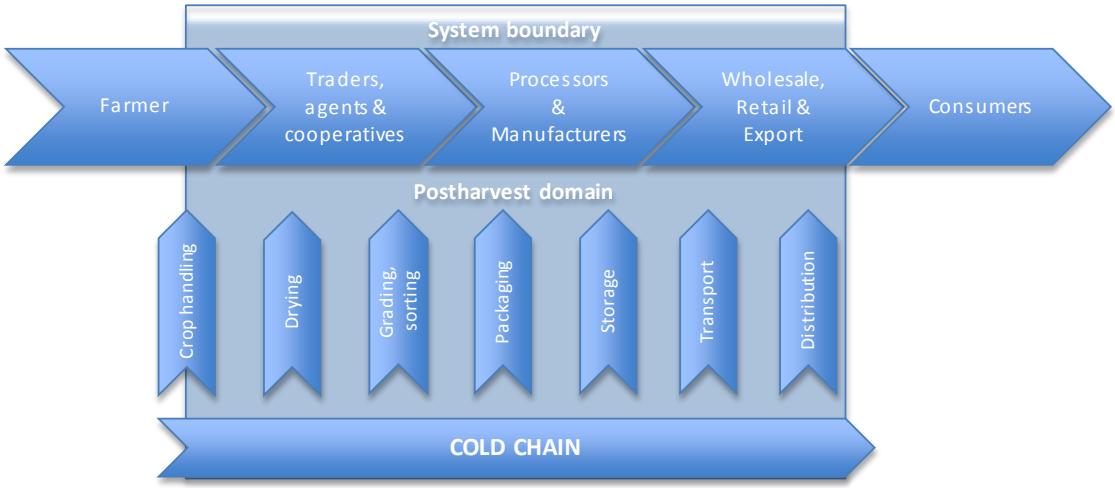
- parties that can have an active role in the network as contributor of specific knowledge and expertise; and
- parties that can have a direct benefit from the network as actor in the supply chain and 'client' of the network.

In both cases the network can enable stakeholders to improve their present (chain) performance through sustained technical and social innovation (e.g. improved quality/quantity of product, technology introduction / -innovation, transfer of knowledge, and training).

1.3. Project boundaries

The definition of the project and the scope of the research into the causes of postharvest losses is determined by a number of boundaries. These boundaries have been described in this paragraph.

Figure 2 Outlining of the postharvest domain in relation to a typical fresh supply chain



Boundary No.1 *Supply chain: postharvest chain*

Explanation The postharvest system comprises interconnected activities from the time of harvest through crop processing, marketing, until the moment of sale to the final consumer (pre-consumer). The fruits and vegetables postharvest chain includes: crop handling, transport, postharvest operations, drying, storage, sorting, grading, packaging, wholesale, distribution, and retail. In general the postharvest system includes all stages in the chain where the activity/service is intended to add value to the final product (*Figure 2*).

Implication Not included in the survey are the losses that arise in the pre-harvest phase and all activities that take place in this stage (including sowing, plant propagation (nursery), cultivation and harvesting). The losses considered that occur in the consumption stage, such as losses generated in the home and out-of-home within the food service sector (i.e. restaurants, catering, hospitality sector, a.s.o.) are not considered.

Boundary No.2 *Theme: Food loss / food waste / postharvest loss*

Explanation Food loss refers to the decrease in food quantity or quality, which makes it unfit for human consumption (8). In most cases this occurs as a result of untimely or improper methods of harvest, storage, distribution, processing, sales or consumption. Food waste is food that is not consumed and discarded as waste at some point in the product chain. Postharvest (PH) loss is often used to describe "losses between harvest and the onward supply of produce to markets and equates broadly with waste in the food supply chain" (21).

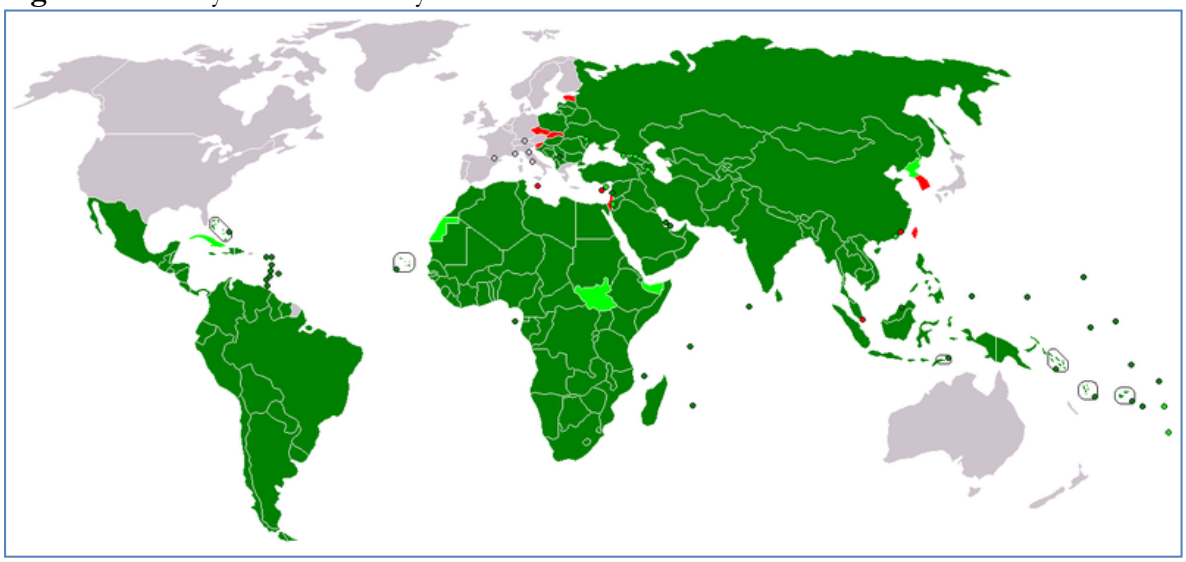
Implication In all cases food is lost as a result of imperfections in the postharvest chain, and/or due to sub optimal performance by actors in the supply chain. Imperfections may arise from the absence of facilities and infrastructure (technical) or can be market imperfections, related to institutional factors. In all cases these food losses are referred to in this report as postharvest losses.

Boundary No.3 *Geography: developing & emerging countries*

Explanation The project's focus on developing and emerging economies derives from the Dutch government's policy to improve worldwide food security (availability and access). The term "developing countries" (DCs) encompasses a wide range of countries with diverse challenges. There are many types of DCs, and the problems in these countries are very diverse and different. PH problems in these countries are also diverse, have different causes, and should be acted upon differently (13). The IMF qualifies a large number of countries as developing, showing a wide range from LDCs to the so-called BRICS countries (see *Figure 3*).

The term emerging countries is used for countries that in their phase and pace of economic development are different from high resp. low income countries. In terms of developed and developing countries these countries are somewhere in between, but as a group also very diverse. In terms of quality and maturity of supply chains for perishable products, emerging countries are considered as developing, leaving ample reason for focussing efforts on reducing postharvest losses.

Figure 3 Country classification by the IMF



dark green - developing economies; light green - developing economies out of scope of the IMF; red - graduated to developed economy
Source: Wikipedia, 2012

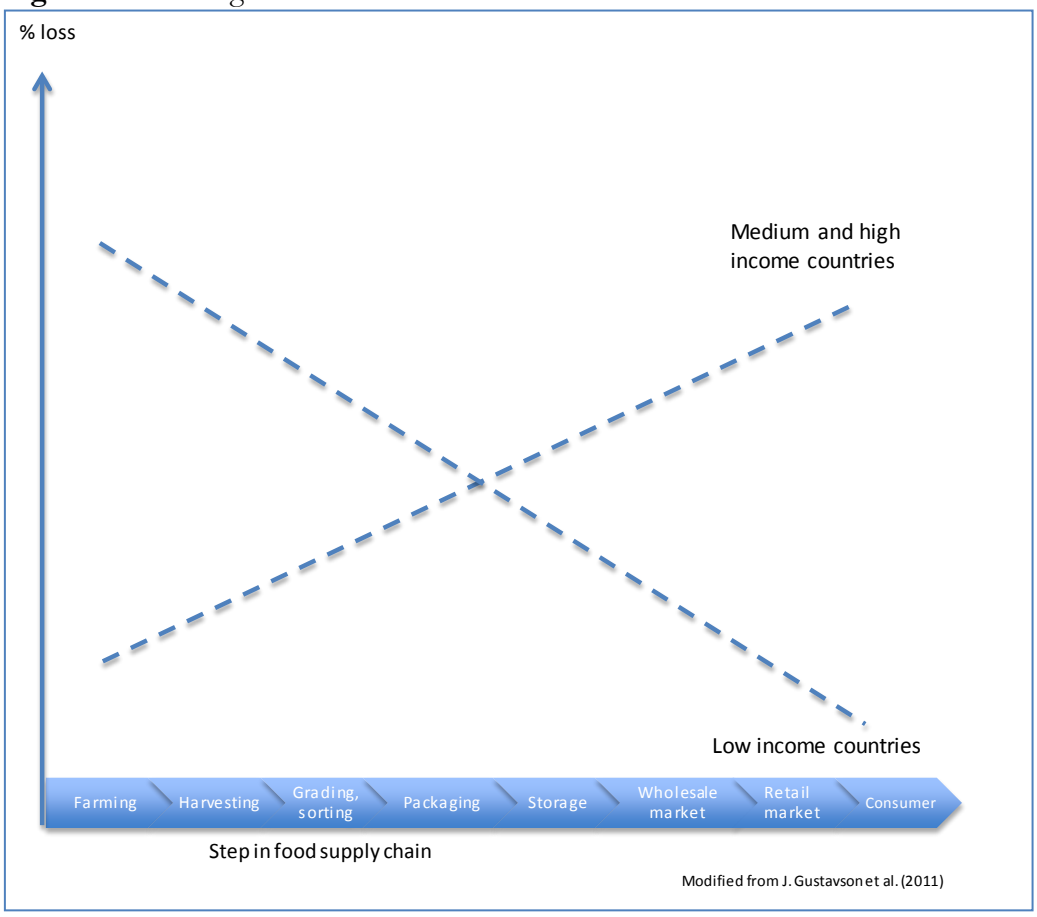
Implication — The research focus is constricted to developing and emerging countries. Without pointing out which countries are included in this categorisation, a distinction merely is made between developed countries and less developed countries. The main reason for this distinction is the difference between these two groups where postharvest losses are most likely to occur. *Figure 4* is a graphic display of the differences between high and low income countries in how food losses develop within the supply chain, and where losses mainly occur. Low income countries show relatively large food losses in the upstream activities, while losses have a tendency to decrease with each following step in the supply chain. For high income countries a reverse trend is observed: relatively large losses at the downstream end of the chain, while postharvest losses in upstream activities are small.

Boundary No.4 — *Product: fruit & vegetables*

Explanation — The research is confined to the product group fruit and vegetables (including roots and tubers). The reason is that in developing countries for perishable products in general, postharvest losses are higher than for cereals, they vary highly by region and type of product. Furthermore, fruit and vegetables are gaining importance in local and global supply chains, generating revenues from export and increasing consumption in local markets.

Implication — Grains & oilseeds, animal protein, dairy, sugar, meat and other food commodities are not included in the survey.

Figure 4 Percentage of food losses - trends



1.4. Structure of the report

The writers of this report have structured the report as follows: insight in the focus and boundaries of the research is provided in Chapter 1. A description of the research methodology follows in Chapter 2. Before zooming in on the causes of food losses in postharvest chains in developing and emerging economies (Chapter 4), the context of the research in terms of global trends and drivers is reviewed in Chapter 3, as well as the considerations regarding the impact of food losses on food security. This chapter also deals briefly with the complexity of quantifying food losses in developing economies. In Chapter 5 the idea of a network of excellence is developed further, by defining a vision and objective and by pinpointing its target group, stakeholders, shareholders, and the focus of the network. This chapter has been drawn-up for debate rather than as fact, and can be used as input in further discussions with the initiating parties in the network. Chapter 6, finally, contains a summary of the main research conclusions, supplemented by a discussion on the opportunities for stakeholders of setting up a Network of Excellence Postharvest Food Losses.

2 Methods

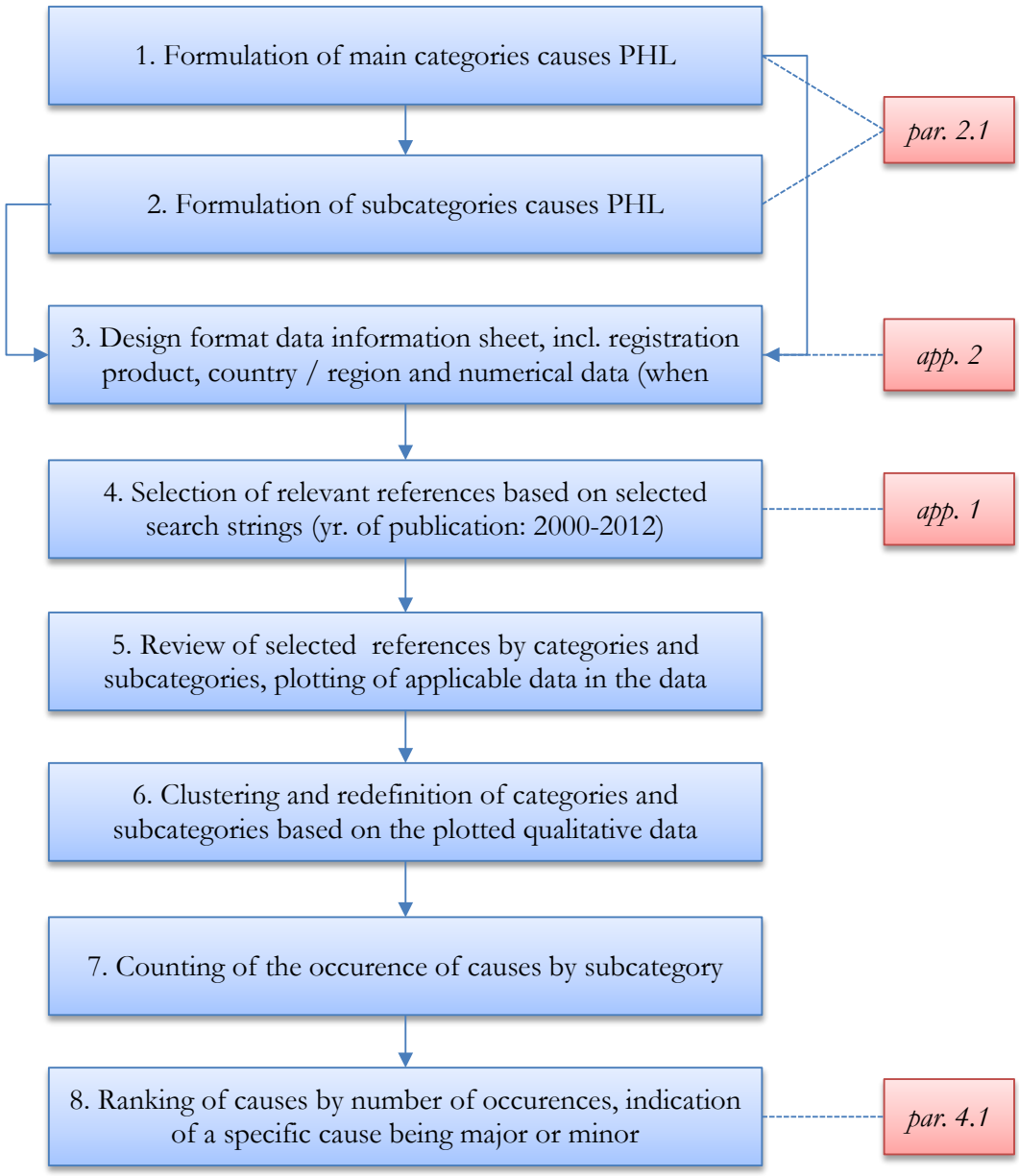
In order to assess the feasibility of setting up a network of excellence, that will be dedicated to reducing postharvest food losses, a number of preceding steps have been undertaken to gain insight in the causes of postharvest losses and on which areas of expertise the network should focus. For this a qualitative survey of available literature and project documentation was executed. References from scientific and project databases on the subject of postharvest food losses and their causes in developing countries were reviewed.

2.1 Causes of postharvest losses inventory matrix

A matrix structure was developed, which enables the processing and structuring of the retrieved qualitative data. Sources with references from scientific literature and project databases were accessed using various search strings associated with postharvest food losses in developing countries. The purpose of the literature research was to perform a qualitative survey of scientific databases on the subject of postharvest food losses in fruit and vegetable sectors in developing countries. In order to retrieve up-to-date information the search was narrowed down to records that were published from the year 2000 onwards.

Figure 5 on the next page presents a schematic overview of the steps in the development of the causes of PHL matrix. The model forms an analytical approach for processing and structuring a large amount of qualitative data, in this case data on postharvest losses in the fruit and vegetable sector in developing and emerging countries. By following 8 consecutive steps, it is possible to perform a quantitative analysis on the qualitative data. The results of using the matrix model are discussed in paragraph 4.1.

Figure 5 Schematic overview of steps taken in assessing the causes of PHL



To list the information from the literature and project survey, and to obtain a systematic set of variables, the records were reviewed by means of a matrix in which the information was divided over a number of main categories and subcategories. The matrix framework with the selected (sub) categories is presented in Table 1.

Table 1 Structure of the inventory matrix causes of postharvest food losses (PHL)

	Main categories						
	Infrastructure:	**Marketing:**	**Technology:**	**Finance:**	**Refrigeration:**	**Organisation:**	**Inputs:**
Sub-categories	• Storage • Road quality • Connectivity • Distance • Energy	• Market information • Chain length • Pricing • Standards in quality & service • Facilities market outlets • Hygiene • Labelling & branding	• Packaging • Grading, sorting • Quality control • (PH) product handling • processing	• Access to credit • Investment analysis • Economies of scale • Production costs	• Transport climate control • Cold chain • Climate	• Relations in business • Available services • Education / R&D • Structure / type of organisation • Social / cultural issues	• Seeds • Crop protection • Water

2.2 Literature and project survey

The first part of the research consisted of an extensive inventory of available scientific literature and reports, as well as a survey on relevant projects implemented by FBR and LEI. A total of nearly 130 records that contained relevant information on postharvest food losses were retrieved and subsequently reviewed (see appendix 1 for a complete overview of the references used in the causes of PHL matrix).

Records that were retrieved from the databases ('hits') were reviewed based on the following questions:

1. What are the causes of postharvest food losses?
2. What are the volumes of these postharvest food losses? (labelled by product/category)
3. Which countries can be linked to these specific causes?

An excerpt of the matrix is included in appendix 2 as an example of how the information from the literature records has been processed and structured.

A similar survey was performed on the database of projects that have been executed by FBR and LEI. The information from the project records that were retrieved was processed in the same way, as done in the literature survey by means of the causes of PHL inventory matrix. Complicating factor in accessing these databases was the quality and completeness of the database, and the limited effect of using specific search strings such as 'postharvest' or 'food

losses'. In many cases such search strings would result in a 'hit' when any of these phrases is included in the title of the project document. Using a wide variety of formulated search strings resulted in a number of hits, however this did not always result in retrieving the applicable project documentation for reasons of non-availability or confidentiality of information. Finally a total of little more than 10 records contained relevant and useful information, which were added to the matrix.

2.3 Interviews stakeholders

The second part of the research involved the taking of interviews with experts and potential stakeholders. The purpose of interviewing representatives of companies and organisations that are involved in fruit and vegetable supply chains in developing countries, was to gain insight in the current practice and in the steps to be taken in order to make progress in the reduction of food losses in the supply chains. It was also intended to connect through these interviews with the ideas, wishes and possibilities of stakeholders, to come to a modus operandi that will effectuate solutions for the reduction of PHL (enabling individual parties to jointly mobilise knowledge, expertise and means).

Representatives were interviewed, either on location or by telephone, by means of a formulated interview script. The interview script is enclosed in appendix 3a.

Stakeholders were identified within the following categories:

Table 2 Stakeholder overview by category

Stakeholder category		*Number identified*	*Number interviewed*	*Participation in workshop*
PRD	Vegetable & fruit production / import	4	2	0
IMP	Wholesale / import	13	3	4
SUP	Product sourcing / import	5	0	0
PRC	F&V processors	2	1	0
TEC	Technology supply	15	3	2
CON	Consultancy	8	1	2
FIN	Finance	9	0	2
TRO	Trade organisations	2	0	2
NGO	Non-governmental organisations	9	3	2
KNI	Knowledge institutes	14	5	5
RNE	Royal Netherlands Embassies	15	4	0
OTH	Other	3	1	1
	Total	**99**	**23**	**20**

A complete overview of potential 99 stakeholders that were identified is included in appendix 3b. In total 23 interviews were conducted within the context of this research project.

In addition, a questionnaire was sent to agricultural counsellors that are stationed at the Royal Netherlands Embassies in developing and emerging countries/regions. The questionnaire was presented as part of the research on the feasibility of a network of excellence to reduce postharvest losses. The purpose of the questionnaire was to:

1. gain insight in the nature of post-harvest losses in the countries of investigation, specifically on vegetables, fruit and dairy.
2. gain insight in the local knowledge partners that have or may play a role developing an infrastructure with knowledge/expertise on the reduction of post-harvest food losses.
3. gain insight in the political agenda with regard to reduction of post-harvest losses.
4. involve liaisons at the RNE's in the development of a network specifically targeted towards the reduction of post-harvest food losses.

A copy of the questionnaire is included in appendix 3c, as well as the list of agricultural counsellors that have been addressed. The filled-out questionnaire was returned by the agricultural counsellor's departments in Brasilia, Buenos Aires, Moscow and Seoul (South-Korea and Taiwan) giving information on postharvest losses in Brazil, Argentina, Kazakhstan, South Korea and Taiwan.

2.4 Workshop

A concluding workshop was organised by Wageningen FBR in co-operation with the contractor, the Ministry of Economic Affairs to disseminate the results of the project and to share views and opinions with the potential stakeholders, including the Ministry of Economic Affairs. The objectives of the workshops were defined as follows:

- To transfer information and share views on the NoE
- To obtain feedback and creative input for next steps in developing the NoE
- To obtain commitment from the stakeholders

3 Postharvest food losses in the supply chain

3.1 Global trends/ drivers

The attention to postharvest food losses in developing countries is due to the persistent problem of losses in quantity and in quality suffered in these countries, increasing demand for better and healthy products in the local markets, need for export in almost all developing countries, demanding importing markets and consumers, demand for quality and healthy products, etc.(4). Besides the implications of food losses for food security and the ethical or moral aspects involved, there are three undisputed drivers that give impetus to taking action upon the reduction of these losses:

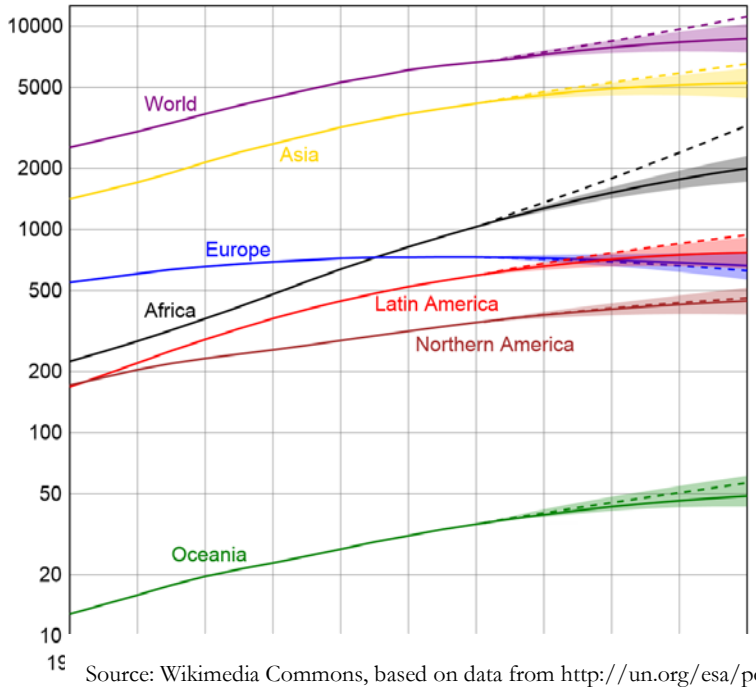
1. Growing insecurity on availability, accessibility and affordability of food
2. Shifting trade patterns and income growth
3. Increasing scarcity of our global resources

Ad.1 Growing insecurity on availability, accessibility and affordability of food

- Growth of world population

  Growth calculation models by the Population Division of the United Nations show a world population prognosis by the year 2050 peaking at 9,3 billion people (medium growth scenario). Figure 6 shows the expected increase of the world population until the year 2050, and how this increase is divided over the different regions. It shows, amongst others, that particularly the African continent will experience a significant increase.

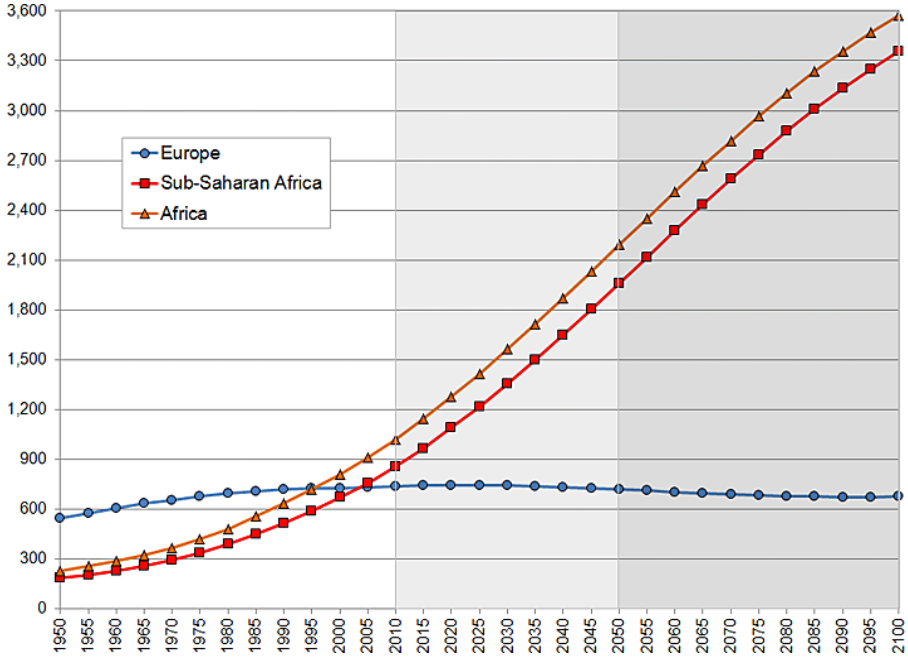
Figure 6 Population of the world and its regions (millions)



Source: Wikimedia Commons, based on data from http://un.org/esa/population

In fact African population will double, adding 1 billion people by 2050. Models that go beyond the year 2050 indicate that this increase will continue also in the second half of the 21st century (see Figure 7). The growth of the world population will put further pressure on the system for food production and distribution and the objective to provide food security for all (zero hunger challenge). World population projections would require that overall food production should be raised by 60 to 70 percent in the decades until 2050.

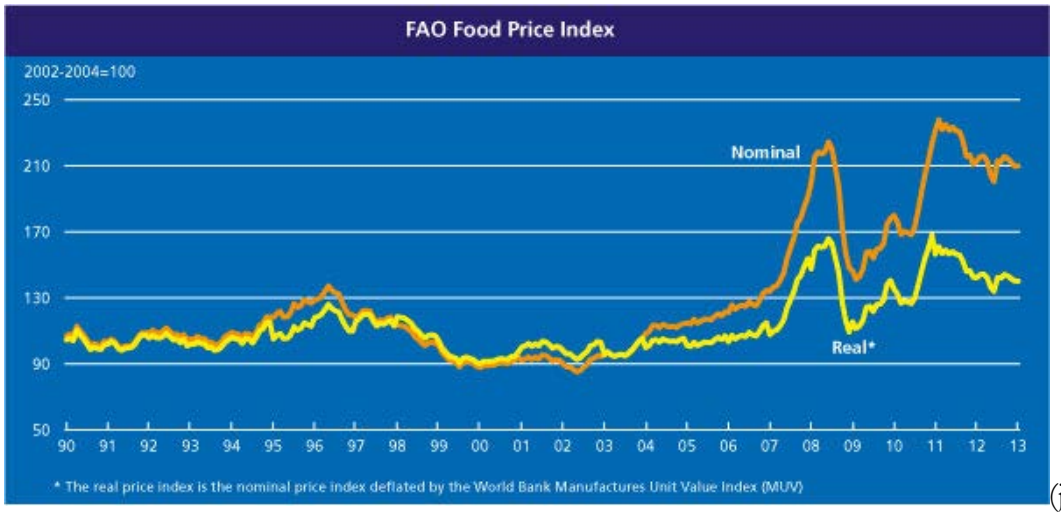
Figure 7 Population of Europe, Africa and Sub-Saharan Africa, prospects



– Increased volatility of food prices

  Projections by the World Bank indicate that food prices may rise 30 to 50% in the decades to come. FAO has called it a new era of international food price movements that is characterised by high levels of nominal and real (deflated) prices and unprecedented volatility in price movements (Figure 8) (22). In other words, stability in food prices as we have known it in past decades will no longer prevail. Higher prices and increased volatility are products of strong demand drivers such as economic growth and shifting dietary patterns in developing countries, and changing biofuel policies throughout the world. A strong supply response is not expected soon. This will bring about a shift in the global food system, inducing an intensified battle for agricultural commodities (23).

Figure 8 FAO Food Price Index 1990-2013

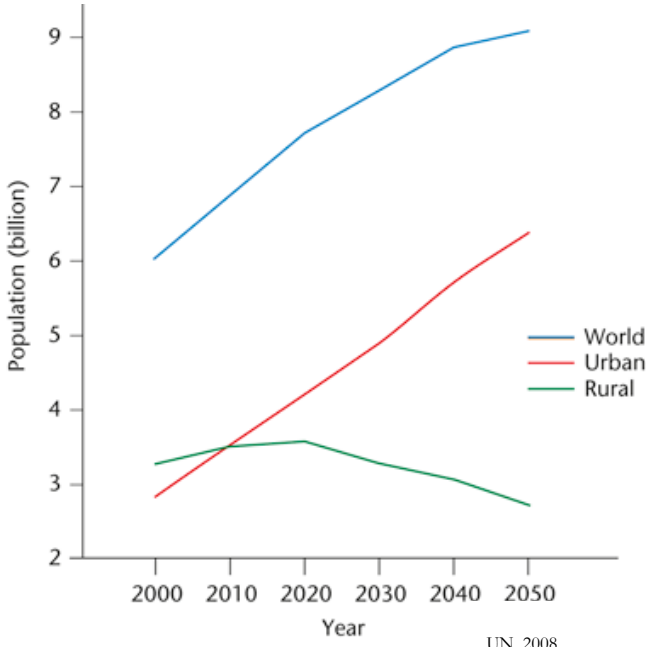


(j)

– Urbanisation

Today, half the world's population lives in urban areas and that number is climbing rapidly. Almost all population growth over the next decades will be urban. Urbanization is particularly rapid in sub-Saharan Africa and East Asia, which have urbanization rates greater than 4 percent and 3 percent respectively. By 2050, about 70 percent of the global population of 9 billion is expected to live in cities (that is a 50 percent increase), which will have important consequences on consumption patterns and food chains (Figure 9) (4).

Figure 9 Population development: world, urban & rural



Ad.2 Shifting trade patterns and income growth

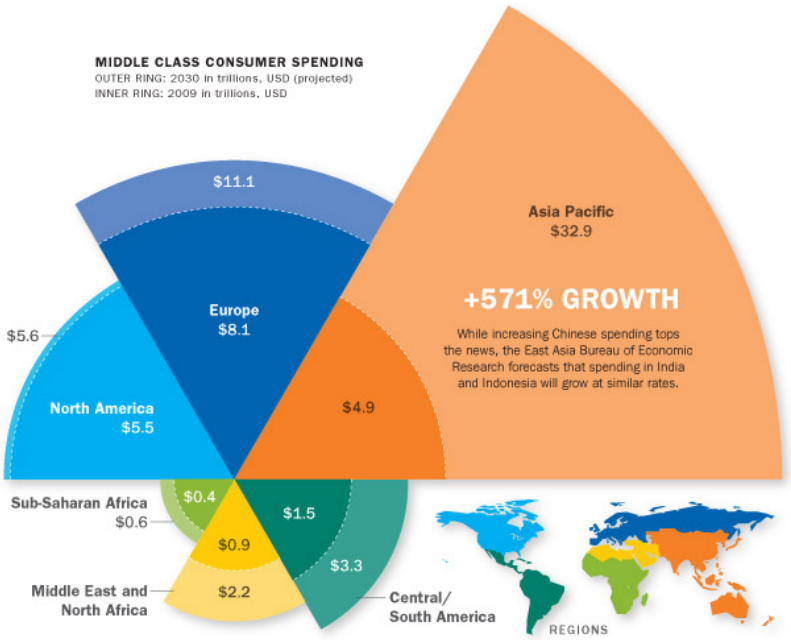
- Increasing global sourcing of fresh fruit and vegetables
  The internationalisation of trade has substantially affected the complexity of (food) supply chains. Horticultural crops play an important role in the economy of developing countries and in international trade. Where supply chains in Western countries are shifting more and more away from local suppliers to the global arena, trade companies increasingly invest in supply chains abroad and in securing a steady supply of good quality product. Driven by consumers and retailers to provide a year-round good quality range of products, trade companies invest in steady supplier relationships. Even where farmers remain linked only to domestic markets, those markets are like to change, partly in response to changes in demand (reflecting income growth and urbanisation) and supply (competition from global markets absorbing more domestic production) (25).

- Concentration in the global supply chain
  Highly concentrated agro-industrial firms and retailers are having an increasingly dominant role in food systems. Increasing retail power is not confined to developed countries. The expansion of supermarkets in food retailing is also increasing in developing countries. As a result, suppliers for the domestic market will come to face similar pressures as those already experienced by suppliers into export markets (5). Retailing is not the only part of agribusiness showing increasing concentration. Upstream parts of the value chain, such as seed supply, show similar trends, as well as downstream at the opposite end of the value chains. Here the growth of large chains in the fast-food sector and their sourcing policies have their impact on how local agricultural production is driven towards larger production units (17).

- Changing consumer preferences and dietary patterns
  Market demand for food will continue to grow. A shift of lifestyles and diet patterns of the rising middle class in emerging economies will give rise to the shift into higher protein products. The McKinsey Global Institute made the prognosis, that in the next two decades to come up to three billion more middle-class consumers will emerge worldwide, mainly in China and India (1). The demand for other food products that are more responsive to higher incomes in the developing countries (such as livestock, dairy products, vegetable oils) will grow much faster than for cereals (20).

  In its Global food security index 2012 the EIU addressed the case that several of the sub-Saharan African countries finished in the bottom of the index will be among the world's faster growing economies during the next two years (including Mozambique, Ethiopia, Rwanda and Nigeria). Rising incomes in these countries suggest that "these countries may be in a position to address food insecurity more forcefully in the coming years" (19).

Figure 10 Middle class consumer spending (2009-2030)



Source: OECD

Ad.3 Increasing scarcity of our global resources

- Food losses and food waste
  Industrialized and developing countries dispose of roughly similar quantities of food: 670 and 630 million tonnes respectively. Awareness is growing that these wasted volumes have a negative impact on the productivity, scarcity and sustainability of natural resources that are used to produce these (wasted) food products. Reducing food waste has been ranked by the McKinsey Global Institute on the third place among the top-15 resource productivity measures that will contribute to improved productivity of resources (2).
- Inclusive wastage of resources
  The actual food loss is only part of the problem; also wasted are all the factors that contributed to producing food (land, water, human & (mechanised) labour, seeds, fertilizer, and every other investment in the crop). When 20% of a harvest is lost, apart from the actual crop loss also wasted are 20% of all the factors that contributed to producing that crop—20% of the land used to grow it and 20% of the water used to irrigate it, along with the human labour, seeds, fertilizer, and every other investment in the crop. In other words, postharvest food loss translates not only into human hunger and financial loss to farmers, but also into tremendous environmental waste. Reducing losses could, therefore, have an "immediate and significant" impact on livelihoods and food security (1,8).

The mentioned drivers, or trends, argue in favour of a shift in the mind-sets of actors and stakeholders that are concerned with local and international food supply chains. After all, the challenge lies in the feeding of the world within the carrying capacity of the planet. That is:

- to make food available, accessible and affordable
- to improve food quality and safety in globalising supply chain networks
- to increase the efficiency of the available resources.

3.2 Postharvest vs. pre-harvest

Postharvest horticulture can be defined at various scales and in various ways. At its widest scale it begins when the product is separated from the plant and ends with consumption by the final consumer. More narrowly, it might be defined as extending from harvest up until the product is in the form in which it will be retailed (1). By any definition, postharvest horticulture involves transformation of product from its state at harvest into its ready-to-consume state. All postharvest activities have two features in common: they add value and they involve members of the supply chain. In this research the 'narrow' definition is taken as a scope of the postharvest chain when addressing the causes that lead to food losses, i.e.: after harvest and before consumption.

By its very nature the quality of fruits and vegetables changes when going through the supply chain, either for good or for worse. These changes can be chemical, biochemical, physiological and microbiological. The activities in the supply chain are therefore all to be directed towards attaining or preserving the optimal quality when the product reaches the consumer. Quality concerns food safety but also smell, taste, texture, nutritional value, etc. (13). It is of course self-evident that pre-harvest production practices may seriously affect postharvest quality and result in the rejection or downgrading of produce at the point of sale. It can in fact be difficult to make a distinction between losses associated with poor farming conditions and postharvest losses. By focussing on the postharvest chain it is therefore not implied that efforts in pre-harvest stages are to be disregarded. Quality starts in the field or orchard and additional environmental factors such as soil type, temperature, frost, and rainy weather at harvest can have adverse effects on storage life and quality (8,18).

While increasing yields, planting improved seeds or growing new crops is very important, much of these investments will continue to be wasted whenever a crop is lost during postharvest handling before it can be eaten or sold. Much more emphasis is therefore needed on improving postharvest handling practices in order to reduce this waste (8). Moreover, the use of appropriate postharvest technologies can provide farmers with options other than immediate sale, and can reduce fruit and vegetable losses.

3.3 Postharvest food losses and food security

Food security is on the top of political and scientific agenda's. Escalating food prices in recent years have highlighted the already difficult access to food for many people in developing countries. On top of this, food losses and wastage have an additional perverse effect, not only from the perspective of resource productivity and overall sustainability of the global food system, but also from the simple fact that reducing waste will improve food availability. Where food losses have an impact on food security for poor people, on economic development and on the environment it is, in other words, obvious that efforts in reducing food losses will have a positive effect on food security (5,24).

Where general consensus exists about the fact that cutting postharvest losses will have a positive impact on food security, the quantification of this impact is less clear. Postharvest losses refer to the measurable quantitative and qualitative food loss in the postharvest system. The phrase 'measurable' is a rather complicated aspect in assessing the volume and scale of PHLs in developing countries. In fact, estimating PHLs in the past has proven to be difficult and not very reliable. Measuring what has been lost implies that it is known what was there at the start and this is usually not the case. On other words: the accurate quantification of food losses and with that measuring their impact on food security still remains a challenge.

PHLs in developing countries are relatively unknown and when quantified are mostly referred to as guesstimates (as best-guess-estimates) derived from questionnaires rather than actual measurements (12). For perishable products (vegetables, fruit, roots & tubers), only little (representative) data are available. Postharvest loss figures that are most commonly used are derived from the 2011 FAO report by Gustavsson, indicating a loss of 25-40% arising between harvest and pre-consumption (see Figure 11). The few data that have been retrieved from the literature research confirm this range, albeit that the lower value is somewhat lower (20% for fruits and 15% for vegetables).

Textbox 1 Estimations of food losses

The study Global Food Losses and Food Waste, commissioned and published by the FAO in 2011, brought forth a number of estimations on food losses that are still to be considered rather indicative and give 'suggested' figures. These data have been cited on several occasions to stress the urgency for acting upon cutting these food losses. The highlights are:

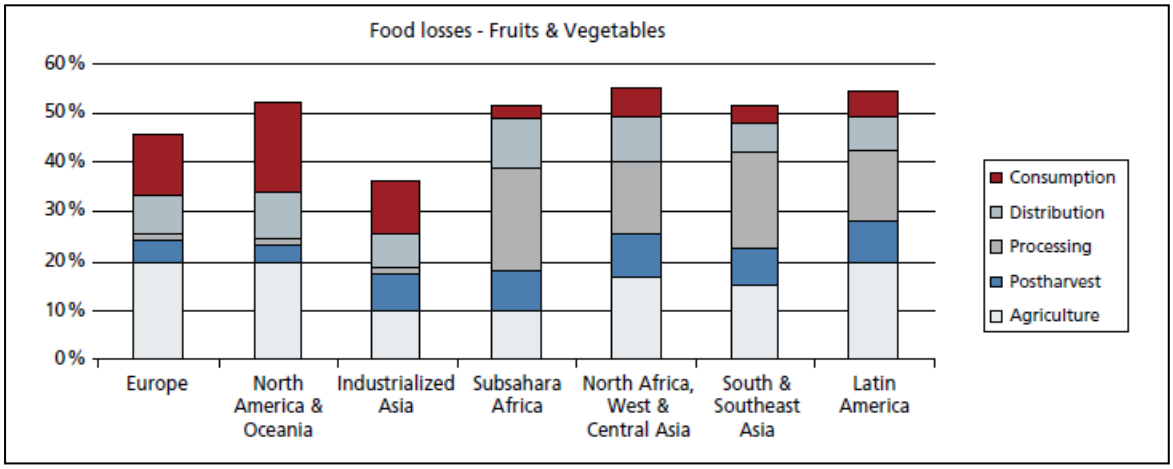
- Roughly one third of the food produced in the world for human consumption every year gets lost or wasted (app. 1.3 billion tonnes)
- Industrialized and developing countries spoil roughly the same quantities of food: respectively 670 and 630 million tonnes
- In developing countries more than 40% of the food losses occur at the postharvest and processing levels (Figure 11)
- Per capita food wasted by consumers in sub-Saharan Africa and South / Southeast Asia is only 6-11 kg/year
- Fruits and vegetables (including roots and tubers) have the highest wastage rates of any food

The data on postharvest losses that have been retrieved from literature refer to postharvest losses for either individual products, or for the category fruits respectively vegetables, or for the combined product category fruits & vegetables. A comprehensive overview of the obtained data on PHL is included in Appendix 4. For the

categories vegetables respectively fruits, and vegetables & fruits, reported postharvest losses were plotted in a line graph, showing the percentage of product lost in the postharvest chain in a specific country or for a group of countries.[2)]

Figure 12 and Figure 13 illustrate the variety of the data of losses, and the wide range of the reported data. Values were plotted in a line graph, each individual data referring to a specific country. From Figure 12 it can be derived that for the category fruits 70% of the used datasets PHL range from 20-40%, and for vegetables 15-40%. Figure 13 is based on the category 'vegetables & fruits', using a different and larger dataset. The range of PHL is here larger, i.e. that approximately 70% of the data lie within the range 15 to 55%.

Figure 11 Part of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions



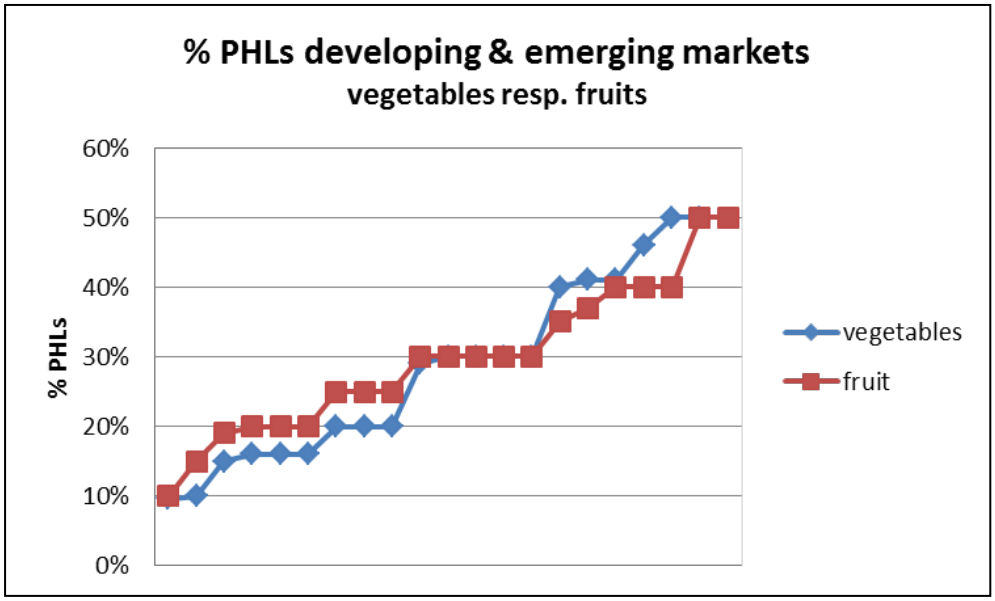
Source: Gustavsson, J. et al., FAO 2011

The wide variety in data and the wide range of measured, or calculated, or estimated losses of fruits and vegetables in the postharvest chain tells us that:

- it is difficult to obtain representative data on losses in the supply chain, and more specifically on losses in the postharvest chain
- postharvest losses are highly variable per product, and per region and country
- postharvest losses are not included in structural data-collection; insight in postharvest losses can only be obtained from data that were collected / produced by occasion (research)
- data collection on PHL over a period of time, measuring possible trends, is absent; measuring progress in time by efforts that are specifically targeted to reducing PHL in the FSC is therefore hampered by lack of sufficient data of good quality

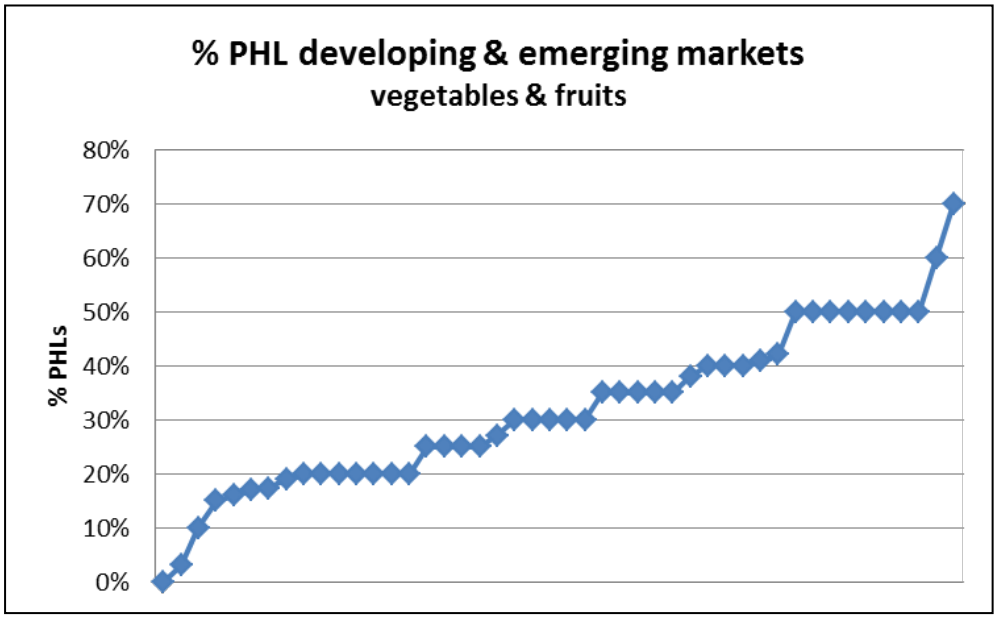
[2)] i.e. developing countries, low-income countries, Africa. Most of the reported data on PHL refer to countries in Asia.

Figure 12 Percentages postharvest losses in developing and emerging markets (1)



Conclusion from this is that by absence of quantitative evidence the arguments over the potential for reducing food losses as a contribution to feeding over nine billion people by 2050 will remain rhetorical, and measuring progress against any reduction target impossible (8).

Figure 13 Percentages postharvest losses in developing and emerging markets (2)



4 Food losses in the fruit and vegetable supply chain

4.1 Causes of postharvest losses in the fruit and vegetable supply chain

As described in paragraph 2 an extensive inventory was done on scientific literature and reports, as well as a survey on relevant projects implemented by FBR and LEI. From the retrieved titles a total of nearly 130 records contained relevant information on postharvest food losses and were reviewed on the following questions:

1. What are the causes of postharvest food losses?
2. What are the volumes of these postharvest food losses? (labelled by product/category)
3. Which countries can be linked to these specific causes?

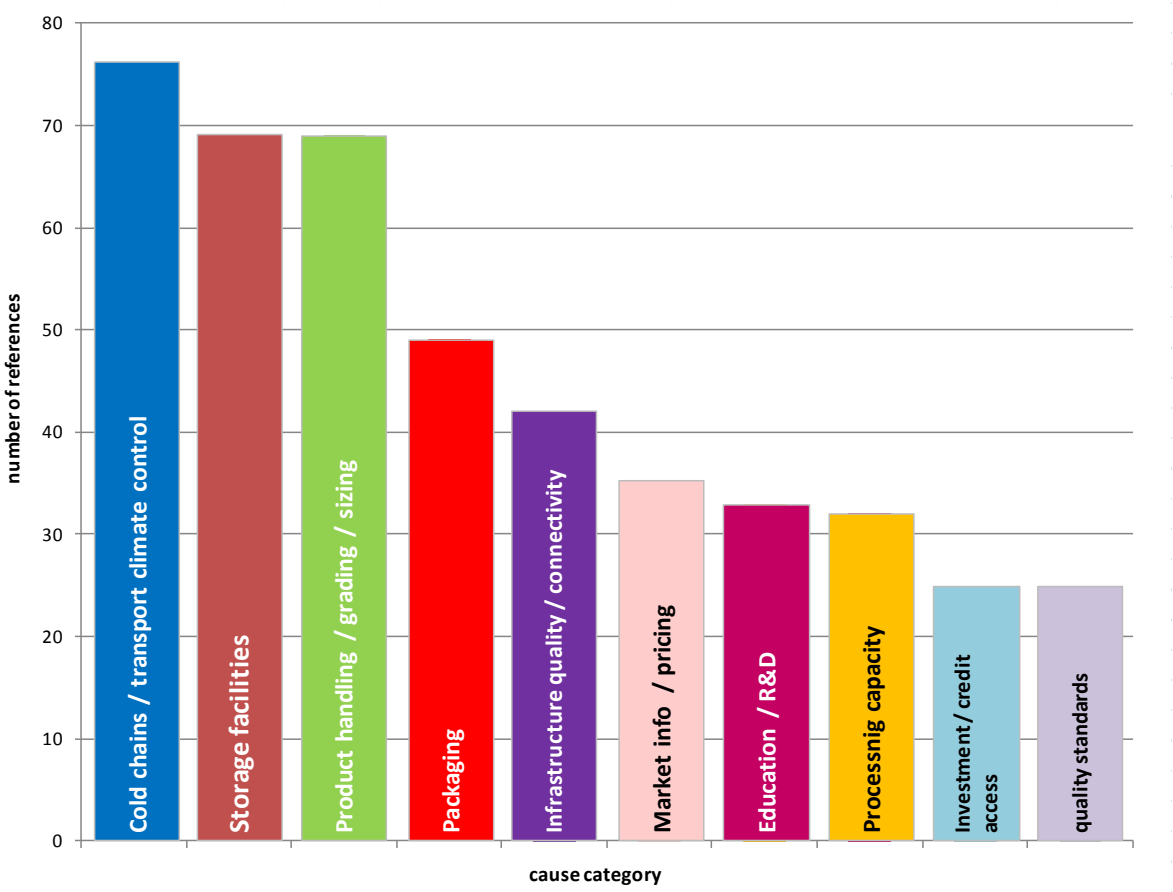
The second question was addressed in paragraph 3.2, regarding the data on PHL that were retrieved through the literature survey. The following provides an elaboration of the first question: the causes of PHL that have been identified and categorised by the number of times that these causes have been mentioned in the references (number of hits). The ranking of the causes is based on the assumption that the number of hits is a measure or indication whether a specific cause is major or minor, in terms of effect on PHL. The results of the survey are described in paragraph 4.1.1.

4.1.1 Results from the literature and project survey

The following tables contain the results of the inventory of the causes of postharvest losses in the fruit and vegetable supply chain in developing and emerging markets. Based on the number of times a specific cause is referred to in the sources of information that have been retrieved, these causes have been ranked by main category and subcategory. The top-10 of main categories of postharvest food loss causes is shown in Figure 14.

The most important causes for postharvest food losses are the cold chain in combination with transport climate control, closely followed by the categories 'Storage facilities' and 'Postharvest product handling'. In total 14 main categories have been identified in order to create insight in the specific problems experienced in the postharvest chain, as well as in specific findings from research on postharvest food losses. Each main category is subdivided in specific subcategories (in total 66), creating insight in the specific causes of PHL.

Figure 14 Top-10 category causes of postharvest food losses



The following tables contain a summary of the top-10 main causes of PHL, with subcategories ranked by the number of references. A complete overview of the 14 main categories and their subcategories is included in Appendix 5.

Category:	1. Cold chain / transport climate control	
Subcategory:	*Explanation*	*Total references*
a. Unsuitable / unfit transportation vehicles	Transport modes (trucks) are not designed or equipped for the (long-distance) transport of fresh produce	36
b. Absence of cold chain infrastructure	An uninterrupted chain of storages, conditioned rooms for processing, refrigerated transport and product display is generally absent	15
c. Poor or limited cold chain infrastructure	Elements of cold chain are partly in place but do not create an uninterrupted cold chain	7
d. Pre-cooling	absence of pre-cooling affecting quality of produce, or when pre-cooling is available it is used poorly	7

Category:	2. Storage facilities	
Subcategory:	*Explanation*	*Total references*
a. Availability of cold storage facilities	No or limited or insufficient availability of cold storage rooms	32
b. Large variation in storage performance / non-adaptive use	Storage performance varies, due to lack of knowledge on operations and settings, relying on fixed rather than adaptive storage climate settings	28
c. Occurrence of diseases and product damages / bacterial damage	Poor monitoring of product quality before entering the storage that spoils other produce, and/or faulty climate settings that affect quality	6

Category:	3. Postharvest product handling	
Subcategory:	*Explanation*	*Total references*
a. Rough handling of produce	Rough handling of produce in the postharvest chain will cause damages to and quality loss	26
b. Poor handling of produce	Absence of grading and sorting in the posthar-vest chain, or poor application of these will lead to increase of losses	25
c. Inefficient, outdated and low level of technology	Technology level in postharvest handling is low, and available equipment is outdated, creating inefficiencies	8

Category:	4. Packaging	
Subcategory:	*Explanation*	*Total references*
a. Inadequate packaging in storage and transport	Use of packaging that is not suited for (long term) storage or for (long distance) transportation	22
b. Low technology packaging	Use of (traditional) packaging with poor material and no design, causing damages to product during handling, storage and transportation	15
c. Inappropriate use of packaging	Overfilling of product packages and wrong stacking of packages causing bruises, dents, punctures in produce; mixing of products	8

Category:	5. Infrastructure & connectivity	
Subcategory:	*Explanation*	*Total references*
a. Poor road quality	Quality of roads that exist is bad, particularly in rainy seasons	7
b. Little investment in infrastructure	Public expenditures on infrastructure (roads, rail, energy) is limited, particularly in remote areas	13

Category:	6. Market information / product pricing	
Subcategory:	*Explanation*	*Total references*
a. General lack of market information	lack of information on prevailing demand, supply and price of fruits and vegetables and vegetables in various markets	18
b. Peak season – low pricing	Overflowing of (local) markets of product abundance during peak season causes surpluses in the market and prices to plummet, creating losses of unsold produce	8

Category:	7. Education / R&D	
Subcategory:	*Explanation*	*Total references*
a. Limited or no education / skills of personnel working in postharvest chain	Workers are untrained or unskilled in operating PH technology and/or unaware of PH protocols	20

Category:	8. Processing capacity	
Subcategory:	*Explanation*	*Total references*
a. Lack of or inadequate processing facilities	No outlet for second and third grade product quality due to absence of processing industry.	14
b. Absence of standards on quality and food safety	Causing (risk of) cross contamination in processing, causing loss of quality	6
c. Low technical efficiency	Generating high wastes and food losses	6

Category:	9. Standards in quality / quality control	
Subcategory:	*Explanation*	*Total references*
a. Produce does not meet quality requirements	Not meeting quality standards particularly relevant in produce for export market, leading to product rejections in country of origin or upon destination in export market	10

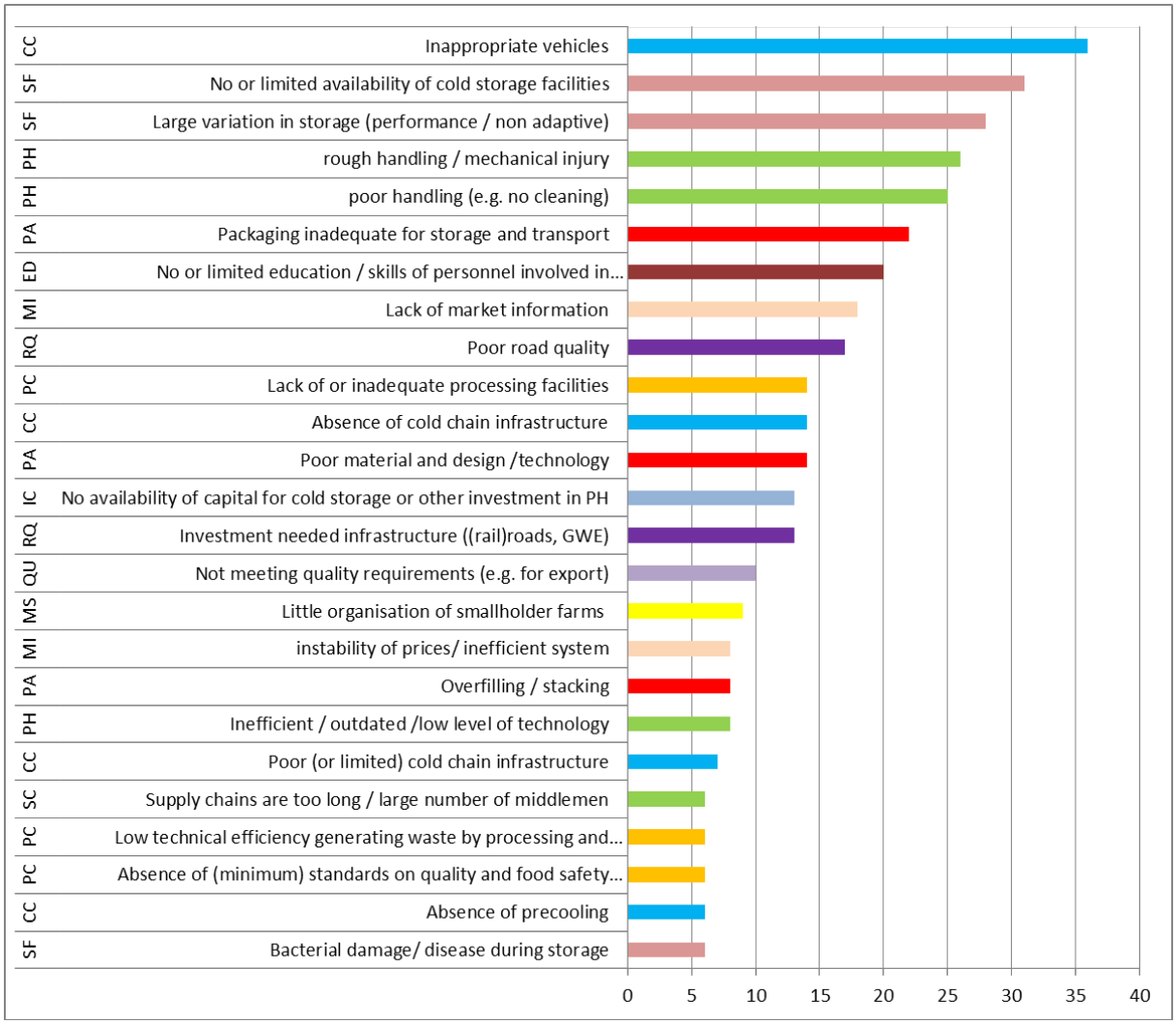
Category:	10. Investment capacity / credit access	
Subcategory:	*Explanation*	*Total references*
a. Absence of capital for investment	Lack of access to capital, collateral (property rights) and high interest rates obstruct investment in postharvest technology	12

The subcategories have been ranked as well by their number of references, see Figure 15.

The overall impression from the survey of the available literature suggests that developing countries are faced with similar challenges in developing a cold chain infrastructure. Weak links in the cold chain or even total absence of a cold chain show that one of the focal points for reducing PHLs will have to be improvement of the cold chain and closing of the cold chain.

It is not possible to make statements on relating specific causes of PHL to specific countries. This would require more data for individual countries, and preferably over a longer period of time. As was explained in paragraph 3.3 the lack of data forms a serious bottleneck in PHL research, especially in developing countries. The variety in the data obtained, is an indication of the fact that the differences in PHLs per product, per country and per region, requires an analysis of individual FSCs, so that tailored solutions for the reduction of PHLs can be developed and implemented.

Figure 15 Ranking of causes PHL by subcategories (>5 references)



4.1.2 Findings from interviews and questionnaires

The question "what are the causes of PHLs" was presented to network stakeholders that were selected and interviewed by the project team. The most important causes of PHLs are technology and knowledge related issues, followed by infrastructural and market infrastructure related causes. The lack of storage facilities, or the poor organisation of these, are part of the main reasons why PHLs in the fruit and vegetable chain occur. The underdeveloped cold chain and the absence of (suitable) transport means contribute to inefficiencies and losses in the FSC as well. The following table presents an overview of the causes of PHLs ordered by the number of times these causes were mentioned in the interviews (number 1 was mentioned most).

Table 3 Causes of PHLs identified by stakeholders

1.	Poor (organisation of) storage facilities
2.	Lack of / no access to finance to address the PHL issue
3.	Lack of /poor quality of transport means
4.	Underdeveloped cold chain
5.	Absence of technical knowledge on specific fruits
6.	Poor infrastructure
7.	Long supply chains
8.	Long transport distances
9.	Insufficient government support
10.	Lack of skilled labour
11.	Management / organisation capacities
12.	Poor local market infrastructure
13.	Inefficiencies in planning, coordination and logistics
14.	Packaging technology
15.	Harvesting technology / PH handling
16.	Few people involved in specialised research (e.g. product quality, nutrition)
17.	Increased fragility of product due to selection of variety and pest management
18.	Fluctuations in quality and quantity

In more than one case it was remarked by the interviewed stakeholder that it is difficult to link PHL to a specific cause, as in most cases there is more than one cause for PHL and causes are intertwined. Another statement was that the problems with postharvest losses are more or less universal and comparable for all developing countries. A similarity in causes of PHL can, however, be observed by producer category, being large respectively small-scale producers.

The questionnaire that was sent to agricultural counsellors in developing and emerging countries, yielded country specific information on PHL. Though the number of returned questionnaires was low, they provided valuable insight in the postharvest chains in Argentina, Brazil, South Korea, Taiwan and Kazakhstan.

In all countries, except for South-Korea and Taiwan, postharvest losses in the fruit and vegetable supply chain are considered a serious problem. In *Argentina* the grain and oilseed sector is dominant and therefore receives ample attention in attempts to cut postharvest losses, which is due to the enormous volumes and impact on the entire Argentinian economy. Postharvest losses as a percentage of the total value are, however, higher in vegetable production than in the grains-/oilseed sector. In *Brazil* performances in specifically the vegetable sector are very much

hampered by lack of knowledge in the various segments of the FSC and by a low technology level. In contrast with the dairy sector, the Brazilian vegetable sector is scattered and fragmented and receives little support from the national government and research institutes. The reports from the Ministry of Agriculture in *Kazakhstan* mention problems with cold store temperature regimes and conditioned transport. Although no specific details were included in the reports, it is imaginable that these problems are caused by outdated and worn storages and storage technologies. In South Korea and to a lesser extent Taiwan, finally, postharvest issues are more related to specific PH knowledge and temperature management.

Table 4 Causes of PHLs for fruit and vegetables reported by RNEs

	ARG	*BRA*	*SOK*	*TWN*	*KAZ*
Training/education: lack of PH knowledge in the FSC	●	●	●	●	
Poor availability of adequate cold storage facilities	●	●	●		
Insufficient / low quality transport	●	●			●
Inadequate packaging in storage and transport	●	●			●
Lack of good understanding of the FSC		●	●	●	
Poor storage temperature management			●		●
Poor cold chain temperature management			●		●
Poor of limited cold chain infrastructure	●	●			
Absence of refrigerated transport	●	●			
Low knowledge at farm level	●	●			
Lack of new technologies / low technology level	●	●			
Lack of good market information	●	●			
Loss of quantity and quality during (untimely) harvest	●				
Technology is too expensive	●				
Tariff & non tariff trade barriers for import of technology		●			
Lack of access to credit	●				
Lack of organisation of farmers	●				
Lack of government incentive/support/control		●			
Non-integrated supply chain: mismatch supply-demand	●				

The 1-2-1 Food Losses Initiative on the perception and possibilities for the reduction of food losses executed a survey in Kenya, Uganda and Ethiopia (28). The main causes for the occurrence of food losses in the value chains (not only restricted the postharvest chain) they identified were:

- The limited training on and access of producers to extension services on skills in pre- and post-harvesting techniques
- The lack of (investment in) storage and cooling facilities
- Lack / absence of processing facilities (on-farm / off-farm)
- Market intelligence, specifically the gap between supply and demand, and the inability to bridge this gap by means of transport to other market areas
- Lack of knowledge on the selection of appropriate (marketable) crops (this is partly related to market intelligence, and the lack of feedback information from other actors in the supply chain))
- Quality of inputs (pre-harvesting), resulting in low productivity and high losses due to consequently poor product quality.

The identified causes for food losses in the value chain in this survey correspond with the input that was retrieved from other countries through our questionnaire. The similarity suggests that causes of PHL are not so much country-related but rather universal. This does, however, not mean that solutions towards alleviating the problem with PHL are universal as well.

4.2 Challenges and opportunities for postharvest solutions

The Netherlands is worldwide leading in sustainable and efficient food production. Dutch agro and food business are part of a strong conglomerate, together with knowledge institutes and service providers, creating the ability to be innovative on a local and global level. The fact that the Netherlands is a world player in the agro and food domain, gives it a unique position and opportunity to contribute to solving global problems and to provide solutions for the elimination of inefficiencies and imperfections in local and global supply chains (29). These also include solutions for the problem of postharvest food losses, that are so persistently present in developing economies. The private sector has a crucial role to play in the process of developing and implementing practical and appropriate solutions. However, the before mentioned complexity of the problem and with that also of the solutions, will require cooperation between value chain actors and other stakeholders in the process, particularly NGOs, knowledge institutes and public agencies.

Further pinpointing of the knowledge that is required to provide solutions for the reduction of these food losses, will establish insight in what expertise and parties will be required to take specific actions. Based on the main categories of causes of PHLs, knowledge components are identified, on which actions are to be undertaken, either in the private or public domain, or in the combined public-private domain (Table 5). The background reason for making this distinction is that certain actions that are deducted from the perspective of PH food loss reductions are the primary domain of investment by the public sector. This is, amongst others, the case for investments in public utilities and services, such as transport- and energy infrastructure, market institutions, food safety, etc. But also in establishing sustainable food systems, public authorities often have an initiating and supporting role in facilitating large scale projects, such as Agroparks

Table 5 Postharvest knowledge components

Main cause of PHLs	*Postharvest knowledge component*	*Domain*	
		Private	Public
1. Cold chain / transport climate control			
	Cooling and refrigeration	●	
	Agrologistics	●	
	Product physiology	●	
	Packaging	●	
	Sustainable food chains	●	●
2. Storage facilities			
	CA & MA storage	●	
	Cooling and refrigeration	●	
	Product physiology	●	
	Sustainable food chains	●	●
3. Postharvest product handling			
	Postharvest handling	●	
	Postharvest (quarantine) treatment	●	●
	CA & MA storage	●	
	Product physiology	●	
	Food nutritional value and safety	●	
	Sustainable food chains	●	●
4. Packaging			
	Packaging	●	
	Product physiology	●	
	Sustainable food chains	●	●
5. Infrastructure & connectivity			
	Cooling and refrigeration	●	
	Sustainable food chains	●	
	Transport infrastructure		●
	Energy infrastructure		●
6. Market information / product pricing			
	Market information	●	●
	Agrologistics	●	
7. Education / R&D			
	Education, R&D	●	●
	Capacity building & system innovation	●	●
8. Processing capacity			
	Fruit / vegetable processing	●	
	Food losses and food waste	●	
	Sustainable food chains	●	●
9. Quality standards / quality control			
	Postharvest handling	●	
	Postharvest (quarantine) treatment	●	●
	Agrologistics	●	
	Product physiology	●	
	Food nutritional value and safety	●	●
	Sustainable food chains	●	●
10. Investment capacity / credit access			
	Agrologistics	●	
	Market information		●
	Capacity building & system innovation	●	●
	Sustainable food chains	●	●

or Metropolitan Food Clusters (spatial- and town planning). In most cases the private sector is considered as leading, although this would not exempt public agencies from facilitating or supporting private sector development.

In Table 6 postharvest knowledge components are linked to Dutch knowledge institutes that have been identified at this phase as supportive in providing the knowledge needed for postharvest development and knowledge transfer. As such, the overview in Table 6 presents the knowledge framework in which network partners will operate, based on a specific demand for postharvest solutions. In a second phase this framework will be complemented by other network participants from private sector and NGOs. Table 6 also contains a more elaborated overview of the available relevant fields of postharvest expertise, linked to one of the identified knowledge partners.

Table 6 PHL knowledge matrix – overview of available relevant expertise

Postharvest knowledge component:	*Knowledge institute: *)*	*Fields of expertise :*	*1. Cold chain / transport climate control*	*2. Storage facilities*	*3. Postharvest product handling*	*4. Packaging*	*5. Infra-structure & connectivity*	*6. Market information / product pricing*	*7. Education / R&D*	*8. Processing capacity*	*9. Quality standards / quality control*	*10. Investment capacity / credit access*
Cooling and refrigeration			●	●								
	FBR	(Pre-)cooling, vacuum cooling		●								
	FBR	Refrigerated transport monitoring, definition optimum conditioning settings	●									
	FBR	Cooling capacity evaluation (official ATP-test station facility)	●									
	FBR	Produce transportation best practices (optimum environments for transport of ffv)	●									
	FBR	Energy savings: input-output monitoring / optimisation	●									
	FBR	Conditioning techniques for transport of perishables	●									
	FBR	Climate control long-distance (reefer) transport of perishables; chilling- and freezing injury research	●									
Conditioned atmosphere (CA) storage				●	●							
	FBR	Conceptual design storage / ripening facilities		●								
	FBR	CA storage monitoring (product quality, energy-input)		●	●							
	FBR	Defining optimum storage settings		●								
	FBR	Interactive storage systems (DCS)		●								
	FBR	(Postharvest) disorder induction for research		●								
Postharvest handling					●						●	
	FBR	Postharvest handling of fresh product (harvesting, sorting & grading, standardisation)			●						●	
	FBR	Postharvest technology innovation			●							
Postharvest (quarantine) treatments	FBR	ripening inhibitors, hot water/heat treatments, light (UVC, LED) treatment, coatings, ozone, electrolyzed water, ethylene control, (GRAS-) chemicals, etc.			●							
	FBR	Non-chemical insect, mite and nematode control (CATT, controlled atmosphere temperature treatment)			●							
Agrologistics			●					●			●	●
	FBR	FSC logistics	●									
	FBR	Quality and supply-chain management to improve production processes and product quality									●	●
	FBR	Tracking & tracing, application of remote sensor technology									●	
	FBR,LEI	Supply chain analysis	●					●			●	●
	FBR,LEI	Supply chain modelling, simulation and optimisation (Aladin)						●				●
	FBR,LEI	Chain information systems						●				
	FBR	Quality monitoring in interactive chains	●								●	
Product physiology			●	●	●	●					●	
	FBR	Product knowledge fruit, vegetables, ornamentals (product requirements: temperature, rel. humidity, ethylene sensitivity/production)	●	●	●	●					●	
	FBR	Quality monitoring, data recording (product testing facility)	●	●							●	
	FBR	Postharvest physiology of horticultural products (maturation, ripening, respiration, ethylene, senescence)	●	●		●					●	
	FBR. RIKILT	Control of post-harvest diseases and pests			●						●	

Table 6 (continued)

Postharvest knowledge component:	*Knowledge institute: *)*	*Fields of expertise :*	*1. Cold chain / transport climate control*	*2. Storage facilities*	*3. Postharvest product handling*	*4. Packaging*	*5. Infra-structure & connectivity*	*6. Market information / product pricing*	*7. Education / R&D*	*8. Processing capacity*	*9. Quality standards / quality control*	*10. Investment capacity / credit access*
Packaging			●			●						
	FBR	Food packaging –preservation of quality and nutritional value				●						
	FBR	Packaging, films & membranes				●						
	FBR	Modified atmosphere packaging (MAP), vacuum packaging, slow release active components packaging				●						
	FBR	Transport packaging	●			●						
Food nutritional value and safety					●						●	
	RIKILT	Assessment of quality and safety of food, risk analysis									●	
	FBR	Chain quality assurance of fruits and vegetables			●						●	
	FBR	Food quality and analysis (shelf-life, taste, discolouration)			●						●	
	RIKILT	Surveying and monitoring of food quality									●	
	RIKILT	Determination of residues, contaminants and micro-organisms									●	
Fruit / vegetable processing										●		
	FBR	Preservation methods and nutrient retention								●		
	FBR	Sustainable processing technology: preservation and prolongation of nutritional value								●		
	FBR,TNO	(Mild) processing techniques								●		
Food losses and food waste										●		
	FBR,LEI	Quantification and prevention of food losses and waste in the FSC										
	FBR	Waste to resource transformation: biorefinery technology food and non-food								●		
Market information								●	●			●
	LEI	Farm information networks						●				
	LEI	Market data collection and modelling						●				
	LEI, KIT	Market and competition analysis						●				●
	CTA	application of ICT for value chain development						●	●			
Education, R&D			●	●	●	●			●		●	●
	CDI,KIT	Enabling and facilitating knowledge and information sharing processes							●			
	LEI,KIT	Farmer entrepreneurship, innovative business models							●			●
	KIT	Strengthening of agricultural knowledge and information system (AKIS)							●			
	FBR	Postharvest research programming, methodology, and research protocols							●			
	FBR	Postharvest training pome fruit	●	●	●	●			●		●	
	FBR	Postharvest training soft fruit	●	●	●	●			●		●	

Table 6 (continued)

Postharvest knowledge component:	*Knowledge institute: *)*	*Fields of expertise :*	*1. Cold chain / transport climate control*	*2. Storage facilities*	*3. Postharvest product handling*	*4. Packaging*	*5. Infra-structure & connectivity*	*6. Market information / product pricing*	*7. Education / R&D*	*8. Processing capacity*	*9. Quality standards / quality control*	*10. Investment capacity / credit access*
Postharvest consultancy			●	●	●			●	●		●	
	FBR	Postharvest applied facility design and operations		●	●				●			
	FBR	Postharvest skills and chain protocols	●		●				●			
	FBR	CA-storage facility protocols		●					●			
	FBR	Quality/disorder expertise, claim support						●	●		●	
Capacity building, system innovation									●			●
	CDI	Designing, facilitating and supporting multi-stakeholder innovation processes							●			
	CDI,KIT	Develop methodologies for improving processes of innovation, learning, capacity development and institutional change							●			
	CDI	Supporting organisations to improve processes of leadership, planning, monitoring and learning							●			
	LEI,KIT	Chain empowerment, supply chain governance							●			●
	LEI	Impact assessment analysis						●	●			●
	TNO	Technical- social, - system innovations and transitions in developing markets							●			
	ISS, LEI	Value chains in developing countries						●	●			
	CTA, LEI	Value chain governance and competitiveness						●	●			●
	CTA	Knowledge management, and communication							●			
Sustainable food chains			●	●	●	●	●			●	●	●
	Alterra,FBR, LEI	Agroparks, Distribution and Consolidation Centres		●	●	●	●					●
	Alterra,FBR	Metropolitan Food Clusters		●			●			●		
	LEI	Certification sustainable supply chains						●	●	●	●	
	LEI,KIT	Development of sustainable chains, chain mapping	●					●	●	●		
	LEI	Sustainable business development						●	●	●		●

FBR: Food & Biobased Research
LEI: Agricultural Economic Research Institute
RIKILT: RIKILT Institute for Food Safety

CDI: Centre for Development Innovation
KIT: Royal Tropical Institute
TNO: Netherlands Organisation for Applied Scientific Research

CTA: Technical Centre for Agricultural and Rural Co-operation
ISS: International Institute for Social Studies

**) The allocation of the mentioned knowledge institutes to the defined fields of expertise is preliminary and is to be confirmed after consultation of the respective institutes.*

5 Network of Excellence postharvest food losses

In the previous chapters the necessity for taking action upon the reduction of food losses in the postharvest chain in developing and emerging countries was explained. The inventory of the main causes of losses occurring in fruits and vegetables supply chains, created insight in the specific requirements to avoid/prevent these losses and the expertise that is needed to achieve this. Given the fact that PHLs can rarely be connected to a single cause or expertise, and there is rather a complex of factors that contribute to PHL, the challenge lies in enabling holistic or system solutions through innovative models of cooperation. A proposed model of cooperation is to set-up a Network of Excellence that is thematically designed to reduce postharvest food losses in developing and emerging countries.

This chapter will look in closer detail into the 'why' 'what' 'who' and 'how' of the Network of Excellence (NoE). An important starting point in the organisation and composition of the network and in the implementation of activities within the context of the NoE is the involvement of local parties (i.e. in the beneficiary country) in the support and capacity building for postharvest solutions. This will increase the chances of successful postharvest innovation, and will in due time decrease the dependency on foreign (Western) experts in the follow-up activities and further development of local postharvest chains.

5.1 Definition of NoE design

Several examples exist of networks that have been set-up with the objective to facilitate the development of food production systems worldwide and to improve food security. Sometimes these networks have matching objectives, but with a different focus or strategy as how to reach these objectives. A list of examples of existing networks is included in Appendix 7. These networks have in common that they all deal with international food production systems and to a lesser extent with food security. They differ in their respective content and focus in modus operandi. Areas of focus are, amongst others, (scientific) research and development, innovation, dissemination of information, business development, promotion, advisory, training, etc. But in all cases these networks have not been developed as an objective by itself, but as tools to provide in the mutual interests of the respective network members and the target groups.

The network's objective(s) and its focus give shape to the network's blueprint which also largely determines the composition of the network members and other stakeholders. The definition of the Network of Excellence Postharvest Food Losses is narrowed down by the following elements:

Figure 16 Network of Excellence definition process

The elements or steps as indicated in Figure 16 have been further elaborated in the following sections. The information included in these sections is based on views and opinions from various stakeholders that have been consulted in the process, complemented with views from the authors. The outcome of this definition process should give input to the further development of the network model, its organisational and business model, safeguarding the substantive and financial viability of the network.

Relevance

The relevance of the Network of Excellence Postharvest Food Losses lies in the blank spots or market niche in which the network will be additional to the current practices in countries where PHL are a major issue. The relevance of the NoE is derived from the fact that:

- <u>available knowledge is fragmented:</u>
  Knowledge of postharvest technology and agrologistics in the FSC is very much dispersed and incorporated in different stakeholders (private sector, knowledge institutes, governmental and non-governmental agencies). The complexity of the occurrence of postharvest losses and the persistent nature of the issue in developing economies requires a system solution enabling a holistic supply chain approach.
- <u>transfer and implementation of expertise as a multi-actor effort:</u>
  Transfer and implementation of expertise is a multi-actor joint effort, and cannot be provided by a single party. The challenge lies in bringing together expertise and abilities of parties that will participate in collaborative modes of working that eventually will enable local innovations in postharvest chains in developing economies.
- <u>addressing postharvest food losses requires a demand driven approach:</u>
  A network with a clear focus on postharvest food losses in the supply chains for fresh fruits and vegetables will facilitate local agri-chain actors to address their problems in terms of postharvest losses in a professional network of parties. As such the NoE will provide a window to supply chain actors in developing markets with specific questions on the reduction of PHLs.

- specialised knowledge infrastructure is absent in countries with high PHL:
  Specialised knowledge infrastructure on PHL is practically absent in developing and emerging markets. Whereas past efforts have been focussed on agricultural production technology and productivity, postharvest research has been lagging behind. Awareness of the importance of reducing losses in the postharvest chain has recently increased, but this has not yet substantiated in the appropriate facilities to perform specialised research on postharvest issues.
- network is a co-operation model that can be used as a tool and not as an objective by itself:
  The NoE is a tool that can provide valuable input to the improvement and optimisation of FSC in developing and emerging economies, including performance in terms of reduction of food losses and increasing (economic) yields in supply chains. The network as such should not be considered as a rigid structure, but rather as a resource for finding partners with specific PH expertise to initiate new postharvest development activities in the FSC.

Vision

- Multiformity of involved parties
  The NoE will contain a multiformity of organisations that combine their respective expertise and networks. Strength of the NoE will lie in the diversity and complementarity of these organisations and in their joint ability to effectuate postharvest solutions.
- Sustain local knowledge development
  The NoE will sustain the local development of a PH knowledge infrastructure and the transfer of PH expertise to local parties.
- Excellence of the network
  The NoE will be formed by a conglomerate of excellent members that have an international reputation and track record in the postharvest supply chain.
- Network impact
  Projects / investments that are initiated within the framework of the NoE should have a visible (quantifiable) impact on local supply chains

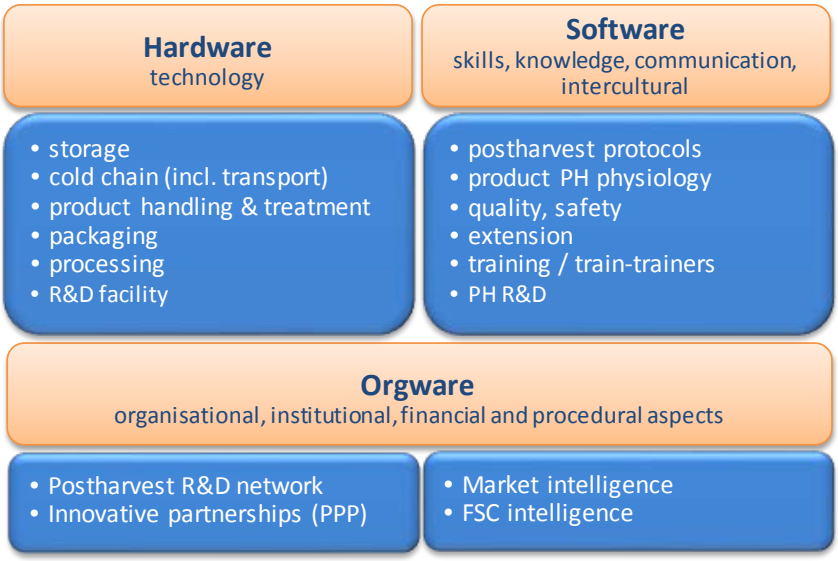
Objective

- PH knowledge
  Enable the transfer and development of knowledge to local parties / institutes regarding postharvest activities and technology, as well as the development of local infrastructure for postharvest research and services.
- Multidisciplinary approach
  Integration of technical and social innovation in PH development processes, addressing the starting point of the NoE that does not engage in technology-push activities, but rather

pursues a multidisciplinary approach (i.e. combination of hardware, software and orgware (see Figure 17).

- Transition of the FSC
  Enable fundamental changes in supply chain systems in developing economies that are sustainable in time. These transitions will have to be initiated on 3 levels, each within their own timeframe:
  1. Physical (technical), economical, institutional
  2. Opinions, values, norms
  3. Routines, rules and behaviour

Figure 17 Network multidisciplinary approach in building PH expertise



Target group

The target group of the NoE consists of parties that have a role in the articulation of specific PH questions and problems. Parties that have a direct interest in solving a specific PHL problem are considered as primary target group, such as:

1. Producer groups, linking small-scale (subsistence) farmers
2. Large-scale farms
3. Trade, logistics, service and retail companies (locally and internationally operating)
4. Knowledge institutes in developing and emerging markets

Parties that have an intermediary role in the articulation of PH questions are considered as secondary target group. These are amongst others:

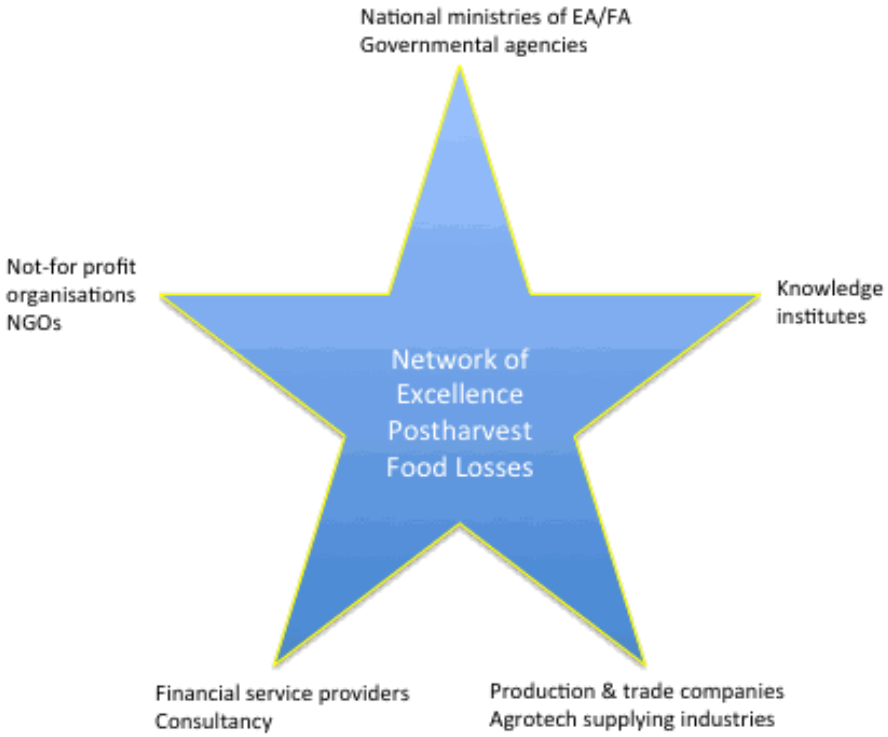
1. NGOs
2. Local extension and knowledge organisations
3. Royal Netherlands Embassies (RNE)
4. Seed breeding and producing companies

Shareholders

The Network of Excellence will consist of an inner circle of actors that commit themselves to the challenge of reducing postharvest losses by making available their expertise and network for the benefit of third parties in developing economies. These actors are referred to as shareholders, as to indicate their commitment and active involvement, rather than to appoint them as 'owners' of the network. Shareholders are identified and selected by their 'excellence', i.e. by their expertise, reputation and international track record in their professional field.

Based on the necessity to establish a network with a multiform character, the shareholders should be recruited from a variety of profit and not-for-profit organisations, including representatives from the public and private sector, research institutes, intermediaries and development organisations. See also Figure 18 presenting these five shareholder categories.

Figure 18 Network of Excellence pentagon of shareholders



Stakeholders

The outer circle of the NoE will include a variety of stakeholders that may have a direct interest in the network's field of operation and activities, and that may participate on a case-by-case basis. Some of these stakeholders are listed below (not exhaustive):

- Multilateral organisations (e.g. FAO, AU, APEC)
- International financial institutions (MDBs and MFIs, e.g. AfDB, ADB, IDB, IFC, FMO)
- Other foreign development organisations (e.g. GIZ, SDC, USAID)
- Foreign sector organisations

Network focus

Product: fruits and vegetables

The NoE Postharvest Food Losses will focus on the supply chains of perishable products, and within this category on the FSC of fruits and vegetables, including roots and tubers. As was argued earlier in this report, postharvest losses for this group in developing countries are higher than those for cereals. Also fruit and vegetables are gaining importance in local and global supply chains, generating revenues from export and increased consumption in local markets. When proven effective, the product focus in the NoE can be expanded to other perishables as well (dairy, fish, meat).

Geography: developing and emerging economies

The NoE will target its activities on postharvest chains in developing economies, as these countries show a relatively large share of food losses in the upstream activities. The selection criteria by which countries are considered as 'developing countries' are rather arbitrary, and different criteria are applied, therefore in this study the IMF classification is used. A graphic display of these countries was presented by *Figure 3*, showing a vast selection of countries with a varied degree in development. The selection also includes countries that are characterised as emerging economies, a term that is used for those countries that in their phase and pace of economic development are different from high resp. low income countries. In terms of quality and maturity of supply chains for perishable products, emerging countries are considered as developing, leaving ample reason for focussing efforts on reducing postharvest losses.

Content

The NoE provides the opportunity to combine expertise in the postharvest FSC and knowledge of individual products thereby improving overall chain efficiency. Product of the NoE is the availability of knowledge and expertise for improvement of postharvest chain performances in the FSC, and the transfer of these to chain actors in developing countries. The network will have a supporting / facilitating role in the matching of supply and demand (of PH knowledge) by connecting a postharvest network of excellent partners with actors and networks in local FSCs in developing economies.

The following is a tentative description of the content of the NoE and what the network's activities would be:

What:	*How:*
Connecting, clustering, matching: The NoE will connect and form clusters of parties from the network that can be matched with parties with a specific PH problem or issue in the target countries (demand driven solutions). The purpose of this matchmaking is to facilitate the transfer of knowledge, to involve knowledge partners in this and so to encourage the sustainability of this transfer process, resulting in reduction of postharvest food losses.	• Positioning of (NL) postharvest knowledge and technology in developing economies. International positioning with front-runners in PH technology (network members) as a 'one-stop-desk' for PH related issues. • Liaise with target groups for the articulation and definition of specific PH problems. • Liaise with local knowledge institutes for strengthening local PH knowledge capacity and - infrastructure. • Liaise with commercial parties in the Netherlands and with chain actors in the targeted countries. Combine and co-operate with different stakeholders within the framework of a multidisciplinary supply chain approach.
Availability of PH expertise: Product of the NoE is the availability of knowledge and expertise for improvement of postharvest chain performances in the FSC, and the transfer of these to chain actors in developing countries. The postharvest knowledge (R&D) network focuses on the increase of the learning ability and capability of local knowledge institutes to develop specialised PH R&D and extension activities in their local markets.	• Provide insight in the PH playing field and access to specific PH knowledge and experts • Organise / facilitate local research capacities and facilities on PH technology. • The NoE facilitates and co-ordinates; implementation is done by the network members • Courses and training (train-the-trainers) • Workshops • Webinars
Project development & monitoring: The NoE will have an active dedicated network moderator (front-office) for the reception of PH questions and the transmission of these within the NoE. As generator of business leads the NoE would have to have a long-term perspective on food security and supply	• Inventory and first selection of PH investment leads • Pre-feasibility analysis and formulation of plan of action, to maximise the effectivity by quick feedback • Encourage partnerships (public, private) • Enabling financing in PH investments

chain sustainability. As such the monitoring of the NoE's impact on food loss reduction is considered important.	• Monitoring of results, and establishing network impact on the reduction of food losses.
Communication: The NoE will broadcast on a specific frequency: postharvest food losses in the FSC.	• Facilitate a network operating system as transmitter on a "PH frequency" • External profiling of the NoE as expertise network in postharvest supply chain performance with a quality label of 'excellence', shaped by the network shareholders. • Internal profiling within the network and co-ordination of the information and reporting network.

5.2 Development of a network structure

In the process of developing the network the NoE would have to pursue a stepwise implementation, from a limited selection of countries to the coverage of a wider range of countries. Which countries are to be selected in which stage of development of the network will have to be decided upon by the network members (shareholders) in consultation with other stakeholders. A possible starting point could be to link the NoE with the 15 partner countries that have been selected in the Dutch governmental programme for bilateral development cooperation. Another approach could be to apply the country interface of Topsector Agri&Food which has identified 10 priority countries (see also Table 7 with an overview of the respective country selections). In any case, the stepwise area coverage by the NoE will include a focus on those countries where PH problems are highly relevant and opportunities arise for the NoE to have an impact on the reduction of losses in the postharvest chain.

Table 7 Overview of country selections *)

10 priority countries Topsector AgriFood International:	*15 partner countries in the Dutch programme for bilateral development co-operation:*	
China	Bangladesh	developing countries with healthy economic growth
South Korea	Ghana	
Bangladesh	Kenya	
Indonesia	Indonesia	
Vietnam	Benin	developing countries with low-income and high dependence to attain millennium goals
Turkey	Ethiopia	
South-Africa	Mali	
Mexico	Mozambique	
Brazil	Uganda	
Russian Federation	Rwanda	
	Afghanistan	developing countries with a fragile constitutional state
	Burundi	
	Jemen	
	Palestinian territories	
	South-Sudan	

*) Topsector Agri&Food theme International resp. Dutch programme for development co-operation

In the planning and phasing of the NoE it will be necessary to adapt a growth path that will enable the gradual development and implementation of the network's activities. On the preconception that the potential network shareholders and stakeholders will be closely involved in the country-selection process, it is suggested to follow a growth path that will enable the development of a well-founded structure:

Short term (1 year): laying the foundations of the network, incl.:

- develop and implement network business model
- develop and implement governance model
- identify and liaise with network shareholders (network frontrunners)
- identify and liaise with network stakeholders
- develop and implement communication plan
- identify and implement pilots

Medium term (2-4 years): expand scope of communication and activities to selected group of countries (group 1-5), incl.:

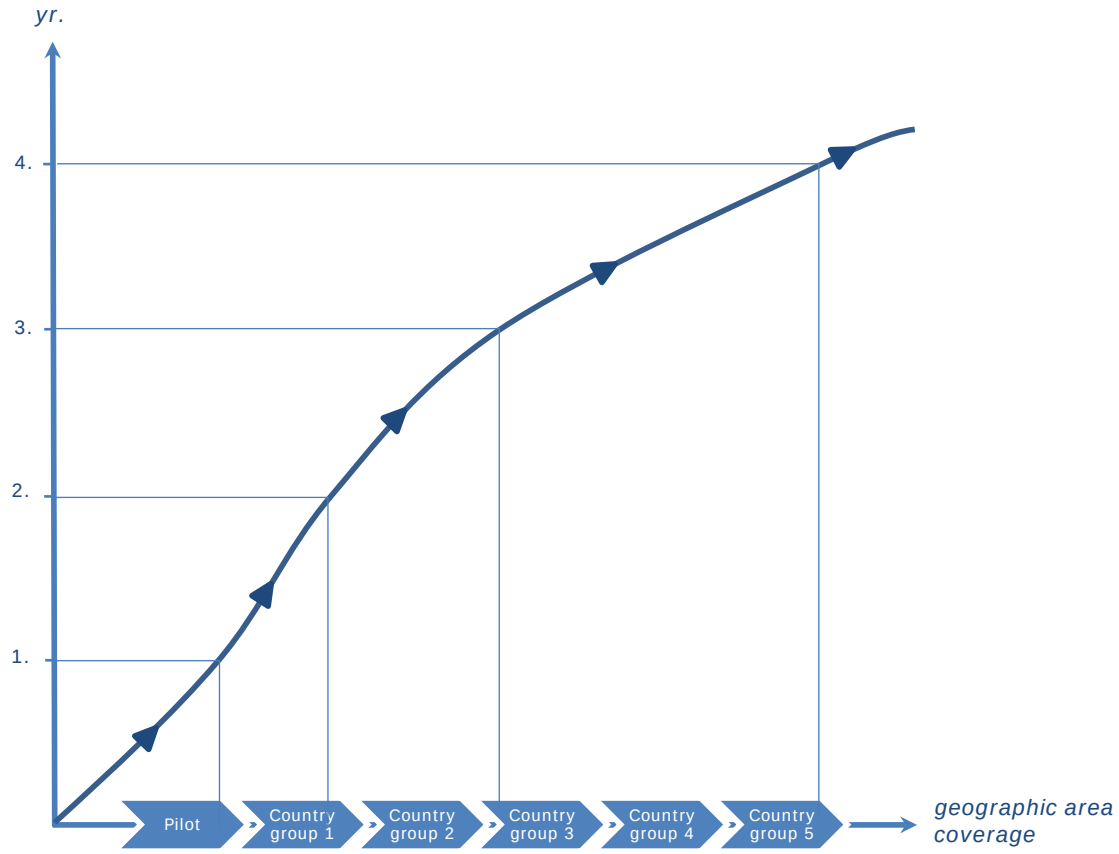
- liaise with intermediary parties for the articulation of PH demand
- develop business and knowledge networks in target countries
- develop and implement programmes and tools for knowledge transfer (PH knowledge agenda)
- extend network shareholders and stakeholders

Long term (5-10 years): consolidate and expand network operation

- consolidate knowledge networks
- expand network scope of operation to other perishables (a.o. dairy, meat, fish)

See also Figure 19 with an indicative growth path for the short and medium term development of the network.

Figure 19 Network of Excellence: growth path (short – and medium term)



5.3 Feedback from stakeholder interviews and the workshop

From a number of stakeholders reflections on the purpose, objectives and activities of the NoE were retrieved. These stakeholders were involved through interviews and through participation in the workshop "*Network of Excellence Postharvest Food Losses: Challenge or Choice*" which was held to discuss about the organisation and content of the NoE. In the following paragraph the highlights of the comments and remarks from these stakeholders are presented. These highlights are

clustered by identifying the network's opportunities, its effectiveness and its target groups / stakeholders. A full report of the workshop is included in appendix 7.

Network opportunities

Stakeholders identified it as an opportunity to profile the network as a postharvest expertise centre that is structured around the ability to develop and transfer specific PH knowledge, and to make use of the (positive) image abroad of Wageningen UR:

Wageningen / Netherlands quality branding:	• The Netherlands should take more pride in its position as a country with a highly sophisticated knowledge infrastructure in fresh supply chains. A network of excellence on postharvest technology has the potential to become a linking pin globally, if it has the ambition to do so. Dutch agribusiness will then benefit from this position. • Wageningen UR would perform a check on the FSC infrastructure and look after the drafting of quality protocols to be able to comply with the required quality in the market ("certified by Wageningen UR" will create trust among the partners in the FSC).
Local knowledge development:	• The network as an entity would provide knowledge in agrologistics, including postharvest technology, in countries where inefficient supply chains yield high losses. • A network of excellence could facilitate the setting up of local knowledge and capacity building programmes, including social innovation. • The network will create additionality by providing knowledge on the design of supply chains and trainings on the application and use of specific innovations, targeted to reducing losses in the FSC.
Support in investment financing:	• A role for the network could be to develop good business cases with farmer-entrepreneurs that are presentable to banks / investing institutions to obtain finance for investment.
Insight in technical innovation potential:	• A network of excellence would create improved insight in the available technical innovations that can contribute to reducing losses in the postharvest supply chain.

Network effectiveness

The interviewed stakeholders are critical in terms of the expected, or required effectivity of the NoE. The outcome and effect of the NoE should be evaluated for their practical output and contribution, as well as by the speed with which the NoE will respond to PH questions. The latter also refers to the ability to manoeuvre towards action from the NoE to the network's 'client'. The following comprises a number of statements or phrases that were expressed by stakeholders during the interviews:

Practical contribution from the NoE:	• The network will prove its relevance if it will develop practical solutions for improved product quality of (organic) fresh fruits and vegetables. The network should contribute to the development of new knowledge and of new (international) alliances. • Networks have a tendency of much talk and little tangible results. A network will therefore only have added value if it will be effective, will bring forth attainable results within a limited period of time, and will be complementary to the vision of the affiliated business partners. • Questions / problems from local parties must be dealt with quickly and solutions should not be too academic. • The value of the network should be that it will create added value to the customers of the individual network members.
Local knowledge development:	• The network could benefit specifically smallholder farms, by implementing a multi-annual training- and education programme. The network should provide a structure to learn from previous experiences, critical success factors, and to develop a basic manual how to improve performances.
Multi-actor involvement / approach:	• The further development of sustainable FSC will require more often chain integrated initiatives in which co-creation and innovation will play an important role. It will require commitment, sharing of knowledge and pro-active co-operation. • Developing action to reduce PHL will require active involvement from business, local knowledge institutes,

	authorities and Dutch embassies. • Multi-actor involvement in the network of excellence will enable a balance between technical and social innovation for reduction of postharvest food losses: 'Golden Square' co-operation between parties from the private and public sector, science and NGOs.
Demand driven approach:	• The network should act upon a demand from 'the market', i.e. from the developing countries. • In order to assess the functions and purpose of a network it is necessary to investigate if there is a demand with local parties, and what this specific demand is.

Target groups /shareholders/stakeholders

The scope of the NoE is determined by the network's focus in terms of product (fruits & vegetables), chain (postharvest) and geography (developing and emerging economies). This will prompt bottlenecks, as was noted by some parties, because the postharvest chain cannot be separated from the activities in the pre-harvest phase. In this respect it was also mentioned that strengthening the chain performance, and the overall sustainability of the supply chain, will be achieved if the processing of fruits and vegetables and/or of waste streams will be considered as well. Also the selection of the network's specific target group(s) and involvement of members and stakeholders will have a deciding influence on this scope as well.

Composition of the network members:	• A network of excellence could play an important role in solving the problem of PHLs if the network will contain organisations that are specialised in this field of expertise. • The network should not be restricted to Dutch members only, but should be open to foreign parties if they provide an additional added value. • Members in the network should be complementary and non-competitive. • Purpose of the network is to connect people and capacities.
Target group:	• It has to be clear which parties will be targeted by the network: farmers that have a relation with the Netherlands through import/export? Local (smallholder) farmers that do not have any linkages with BV Netherlands? Other target groups?

	• Farmers in developing markets will have to organise themselves, and have to take care of sufficient volumes, a uniform quality and packing house facilities. It requires taking small steps from consolidation in one location, to further development towards compliance with specific product standards imposed by international trade partners. • The main problem of PHLs is that a complexity of different causes plays is involved. The network should not address the reduction of postharvest losses only, but consider it as part of agricultural development. The focus of the network should therefore be broader than only PHL.
Multi-actor involvement / approach:	• Trade companies have an interest in expanding their suppliers' base and to look after robust supply chains. This requires involvement of all chain partners, including (local) authorities, NGO's, inspection services. A dedicated network can contribute knowledge and facilitate local research institutes to review supply chains and to implement pilots.
Political / institutional obstacles:	• Investing in the cold chain in overseas countries and in controlling the FSC may be impeded by local interests and monopolistic positions of local parties in the supply chain. It remains to be seen whether a network will be able to provide leverage to break through vested local interests.

5.4 Concluding remarks

The following overview presents some of the conclusions regarding the network's opportunities, effectiveness and target groups/stakeholders/shareholders that were drawn from the input by the involved stakeholders / potential network members:

Demand pull	The NoE should be driven by a clear and concrete demand on postharvest issues in developing countries. The network will perform an intermediary role as matchmaker between network members and network clients.
Product = PH knowledge	Product of the NoE is knowledge on reducing postharvest losses in the FSC for fruit and vegetables, and making this knowledge available to chain actors in developing countries

Membership by excellence	Excellence is to be profiled as a quality label in the international positioning of the network. Potential members should be invited to the network on the basis of their performance and profile as frontrunners in their field of expertise. The network will have its basis in the Netherlands, but should be open to parties from other countries as well. Guiding principle should be that network membership is based on excellence and complementarity rather than nationality.
Network organisation	For daily network operations it is necessary to have a dedicated moderator, responsible for co-ordinating activities, communication, network exposure and representation, etc.. The network and its moderator/controller should form a linking pin within the network and between the network and its (potential) clients
Internal network	A need exists to get to know each other (to build confidence), learn from each other and to establish a basis for co-operation through concerted network action. Also insight in providers of postharvest solutions is appreciated (network/information database, 'yellow pages'
Short term implementation	One or two network pilots should be organised to initiate action on a short term basis. Short-term action was stressed by some stakeholders to be preferred over long-term network development.
Finance	The network should have access to financial resources for implementing the network activities. Provision of seed money in the start-up phase and for developing the network organisation will be needed.
Finance enabling	The network will enable access to financial networks / service providers for investments in postharvest solutions.

6 Conclusions

According to the FAO nearly one-third of the food produced for human consumption is either lost or wasted. While developed countries show significant waste at retail and consumption stages, in developing countries losses occur at the earlier stages of the supply chain. Reduction of these losses in the postharvest chain will have a substantial impact on improving food security, as well as on the efficient use of available resources (soil, energy and water). Attempts to quantify these losses for fruit and vegetables supply chains , and with that measurement of the impact of reducing these losses on food security, is complex and characterised by a wide range in measured volumes and estimations of these losses. Data on postharvest losses of fruits and vegetables vary from 10-50%, depending on the type of fruit or vegetable, and the region or country. Nonetheless, the main bottleneck in quantifying the impact of losses on food security lies in the lack of data about losses that occur in the postharvest fruit and vegetables supply chain.

In developing and emerging economies the causes of fruit and vegetable losses in the postharvest chain are diverse and often interconnected. Through research of publications, reviews of implemented projects, and interviews on this topic with stakeholders, an overview has been drawn up of the major causes (divided in respectively main – and subcategories). By plotting the findings into a matrix model the registered causes of PHLs- have been categorised, providing insight into how often a specific cause has been addressed to as reason for the occurrence of PHLs. As such the model presents a degree of urgency to address these causes, with on top the cause of PHLs that has been addressed most often in the review:

1. Cold chain / transport climate control	a.o. unsuitable transportation vehicles, absence of cold chain infrastructure, poor or limited cold chain infrastructure, absence of pre-cooling
2. Storage facilities	a.o. availability of cold storage facilities, large variation in storage performance / non-adaptive use, occurrence of diseases and product damages / bacterial damage
3. Postharvest product handling	a.o. rough handling of produce, poor handling of produce, inefficient /outdated/low level of technology
4. Packaging	a.o. inadequate packaging in storage and transport, low technology packaging, inappropriate use of packaging
5. Infrastructure & Connectivity	a.o. poor road quality, little investment in infrastructure

6.	Market information / product pricing	a.o. general lack of market information, peak season – low pricing
7.	Education / R&D	a.o. limited or no education / skills of personnel working in postharvest chain
8.	Processing capacity	a.o. lack of or inadequate processing facilities, absence of standards on quality and food safety, low technical efficiency
9.	Standards in quality / quality control	a.o. produce does not meet quality requirements
10.	Investment capacity / credit access	a.o. absence of capital for investment

The fact that these causes are often intertwined suggests that defining and implementing solutions to reduce PHLs is not one-dimensional, but requires a holistic approach that will entail different expertises and capacities. A value chain approach will require impact on different levels (i.e. hardware, software and orgware). A network structure would enable the establishment of linkages between parties that individually are able to provide part of the solution, but as a conglomerate would be able to implement a system solution (see also Chapter 7 'Discussion: opportunities for a thematic network of excellence').

Dutch stakeholders embody a vast array of knowledge and expertise in the fruits and vegetable supply chain, including the postharvest chain. The position of the Netherlands in the world as prominent trader in fresh products is an indication of this high expert level. Likewise Dutch suppliers of equipment and innovative technology in handling, processing and storage of fresh produce provide solutions that enable producers and traders in local markets to develop and optimise FSCs. Whether it concerns production of fruits and vegetables for the local market or production for the export (international) market, the necessity to invest in the development of local FSCs is illustrated by the losses that occur in the postharvest chain. The Dutch network of knowledge institutes (can) play an important role in supporting technical and social innovation in the increasingly globalising chains. Other stakeholders are NGO's and intermediary organisations (a.w. financial service providers, consultancy) that have a role in the articulation of specific postharvest questions, as well as a role in the transfer of knowhow and expertise to local chain actors. Inclusion of representations of these stakeholders in the inner circle of the network will strengthen the network's ability to switch from demand for to supply of solutions for the reduction of postharvest losses in specific countries and specific supply chains. Whether the NoE should be restricted to, or not limited to, Dutch stakeholders is a matter for debate in the process of formation of the network. The outer circle of the NoE will include a variety of stakeholders that may have a direct interest in the network's field of operation and activities (multilateral organisations, international financial institutions, development organisations, sector organisations).

From interviews and a workshop held in January 2013 with stakeholders in the Netherlands, it was concluded that the concept to tackle the problem of food losses in the postharvest fruit and vegetable supply chain by providing a holistic approach is endorsed. The private sector shows interest to join efforts with knowledge institutes in positioning Dutch expertise in the field of postharvest technology and supply chain management in developing markets. Likewise NGO's and intermediary organisations expressed their need for insight or knowledge of what the Netherlands has to offer in optimising FSCs, including reducing postharvest losses. The common denominator is that the NoE should be demand driven. This refers to the opinion that the network should be driven by a clear and concrete demand on postharvest issues in the developing countries. As a product the network will 'retail' knowledge on the reduction of postharvest losses in the FSC for fruit and vegetables. By performing an intermediary role as matchmaker between network members and network clients, the NoE will disclose this knowledge to chain actors in developing countries.

7 Discussion: opportunities for a thematic network of excellence

Paragraph 4.2 referred to the prominent position of the Netherlands as producer of and trade-nation in agricultural and food products, being internationally praised and recognised. The "Golden Triangle" model is often cited as an effective innovation model with different stakeholders and their respective complementary expertise and networks, who have a shared interest to innovate. The phrase "Golden Triangle"[3)] refers to the co-operation between the private sector, knowledge institutes and the public sector, which successes have yielded a highly innovative sector, strengthening the status of the Netherlands as international frontrunner in sustainable agriculture and food production. As such the Dutch "Golden Triangle"-model is a reference to the statement that innovation and development is a combined effort in networks that contain different stakeholders, and that bring mutual revenues.

As mentioned earlier, the starting point, or if you like ambition to provide a holistic or system solutions for the reduction of postharvest losses in the FSC, will require involvement from different parties that are able to provide expertise in different fields. The challenge lies in developing and implementing solutions that are case- and in some situations culture specific. This does not only refer to the capacity to innovate technically, but also to social innovation. In this context social innovation refers to the transitions in supply chain systems in terms of routines, rules and behaviour that are practised in daily operations in the FSC. In international entrepreneurship and co-operation social innovation refers also to the differences in culture and perception between parties, that on the one hand provide a solution and on the other hand those parties that have to implement or work with this solution.

Postharvest knowledge and the transfer of it to the identified target groups is key within the context of the Network of Excellence . Knowledge will only be effective in its contribution to development if it will be accessible for the envisaged user group. Dutch networks can contribute to local development, but for this there must be good insight in the local knowledge infrastructure and how this is related to the practice. The question which complementary role can be fulfilled by the Dutch network and how knowledge can be disseminated effectively within the local knowledge infrastructure and within the sector, are issues that will have to be addressed and structured within the network's programming and activities. A long term perspective is precondition for developing qualitatively high value knowledge (27).

The challenge, therefore, lies in mobilising the available expertise and in establishing a unique selling point as a network, thereby creating 'additionality' to other existing networks. A large number of varied national and international networks exist and are dealing with agricultural development and food security, with varying focuses on content and activities. The NoE can use these networks for the definition of its own content and focus, thereby creating an additional

3) Formerly referred to as the OVO-model, Dutch abbreviation for research, extension and education

value to related existing networks, and to link with these networks, creating mutual strengthening. Appendix 8 contains a selection of networks that are in one or another way related to or linked with the NoE Postharvest Food Losses. From the point of view of network content and focus of these networks, it can be concluded that based on the starting points and focus as defined in the previous chapter, the NoE can have an additional value as a thematically focussed collaboration between different stakeholders in the area of food security and optimisation of food production. Naturally this is not by default, but will have to be shown by the impact of the network on the reduction of food losses in the FSC.

The opportunities to establish a network of excellence on the reduction of post-harvest food losses can, therefore, be summarised by the following arguments:

- High visibility of food losses and waste in international committees and forums has raised the level of priority given to action based programmes with the objective to reduce postharvest losses.
- Profiling joint expertise in a Network of Excellence to reduce postharvest food losses will increase the visibility of Dutch expertise in this field worldwide.
- Dutch agro-production, trade and technology partners recognise international potential to explore and exploit opportunities in support to developing / improving local FSCs.
- Dutch knowledge institutes are internationally renowned for their high level of expertise and applied approach in agricultural sector development, and as such represent a brand in agro and food production. By profiling in the NoE institutes that are specialised in postharvest technology and postharvest / supply chain management, and adjacent fields of expertise, Dutch knowledge branding can be strengthened.
- International and local networks of NGO's and intermediary organisations are complementary to the activity-based approach of the NoE, including their respective knowhow in knowledge transfer and technical innovation.

The long-term feasibility of the concept of the NoE will depend, amongst others, on the financeability of the network organisation and activities. To determine this it will be necessary to develop a financial model that give insight in the operational costs of the network, as well as the revenues that are foreseen in respectively the start-up phase and the following phases of the network. In short the second phase should entail:

1. Identification of and commitment from key partners: network partners that will commit as a group of frontrunners in the development phase of the network.
2. Definition of activities: define the product, markets and activities of the network organisation (incl. communication).
3. Business model canvas: develop a business model with short-, medium- and long-term projections (incl. organisational and governance structure).

4. Financial model: create insight in cost structure and revenue streams, assess financeability of short-, medium- and long-term projections.
5. Pilot (optional): bring into practice the concept of the network of excellence in preselected country(ies) and product chain(s).

*****

References

Websites

a. http://www.fao.org/inpho/en/
b. http://postharvest.ucdavis.edu/
c. http://www.foodnet.cgiar.org/PhAction/index.htm
d. http://foodsecurityindex.eiu.com/
e. http://www.postharvest.org/home0.aspx
f. http://www.poscosecha.com/es/home/
g. http://www.aphlis.net/
h. http://www.sdc-foodsecurity.ch/en/Home/Focus_areas/Post_harvest
i. http://www.9billiontofeed.com/UK/
j. http://esa.un.org/unpd/wup/index.html

Literature

1. Collins, R. (2009). Value chain management and postharvest handling: partners in competitiveness. From: Postharvest handling: A Systems Approach. Eds.: (eds.) Wojciech J. et al., p.107-127. Elsevier Inc., New York USA.
2. Dobbs, R., Oppenheim, J., Thompson, F.. Brinkman,M., and Zornes, M. (2011). Resource Revoluion: Meeting the world's energy, materials, food and water needs. McKinsey Global Institute, London, UK.
3. FAO (2011). Food Loss reduction Strategy. Food and Agricultural Organization of the United Nations, Rome, Italy.
4. FAO/OECD (2011). Improving food systems for sustainable diets in a green economy. Working document 4. FAO/OECD Expert Meeting on Greening the Economy with Agriculture. Paris, 5-7 September 2011.
5. Gustavsson, J., Cederberg, C., Sonesson, U., Otterdijk, R. and Meybeck, A. (2011). Global food losses and food waste: extent, causes and prevention. Food and Agricultural Organization of the United Nations, Rome, Italy.
6. Hodges, R.J., Buzby, J.C., Bennet, B. (2010). Postharvest losses and waste in developed and less developed countries: opprtunties to improve resource us. Journal of Agricultural Science 149, 37-45. Cambridge University Press.
7. OECD (2011). A green Growth Strategy for food and agriculture. Joint working party on Agriculture and the Environment, Paris.
8. Parfitt, J., M. Barthel and S. Macnaughton (2010). Food waste within food supply chains: quantification and potential for change to 2050, Philosphical Transactions of the Royal Society – Biological Sciences: 3065-3081.

9. Prusky, D. (2011). Reduction of the incidence of postharvest quality losses, and future prospects. Food Security vol. 3, issue 4, p.463-474. Springer Science+Business Media B.V. & International Society for Plant Pathology, www.spingerlink.com.
10. Redlingshöfer, B., Soyeux, A. (2012). Food losses and wastage as a sustainability indicator of food and farming systems. Conference paper 10th European IFSA Symposium: Producing and reproducing farming systems. New modes of organisation for sustainable food systems of tomorrow. 1-4 July 2012 Aarhus, Denmark.
11. Saran, S., Roy, S.K. and Kitinoja, L. (2012). Appropriate postharvest technologies for small scale horticultural farmers and marketers in Sub-Saharan Africa and South Asia. Acta Horticulturae 934, p.41-52. International Society for Horticultural Sciences, Leuven, Belgium.
12. Snels, J.C.M.A. and Westra, E.H. (2008). Export from Argentina to Europe: getting across. Start-up of a sustainable vegetable and fruit trade flow from Argentina to Europe. Report nr. 891. Agrotechnology and Food Sciences Group, Wageningen UR.
13. Yahia, E.M. (2005). Postharvest research and reality in developing countries. Acta Horticulturae 682, p.1655-1666. International Society for Horticultural Sciences, Leuven, Belgium.
14. Yahia, E.M. (2010). Cold chain development and challenges in the developing world. Proceeding at the VI International Postharvest Symposium, Antalya, Turkey. Acta Horticulturae 877, 127-132. International Society for Horticultural Sciences, Leuven, Belgium.
15. Godfray, H.C.J. et al. (2010). Food security: the challenge of feeding 9 billion people. Science 327, 812 (2010). American Association for the Advancement of Science (AAAS), Washington DC.
16. Schwab, K., Sala-i-Martin, X., Brende, B. (2012). The Global Competitiveness Report 2012-2013. World Economic Forum, Geneva Switserland.
17. Humphrey, J. (2007). Policy implications of trends in agribusiness value chains. The European Journal of Development Research, 18:4, 572-592. Rouledge, London.
18. Government Office for Sciences (2010). Workshop report W4, Expert forum on the reduction of food waste. Foresight Project on Global Food and Farming Futures. 23-24 February 2010, London.
19. Economist Intelligence Unit (2012). Global Food Security Index 2012 – an assessment of food affordability, availability and quality. The Economist, London.
20. High-level Expert Forum (2009). How to feed the world in 2050 – global agriculture towards 2050. FAO, Rome Italy.
21. Parfitt, J. & Barthel, M. (2011). Food waste reduction: a global imperative. Resource Futures / WRAP, Bristol, UK.
22. FAO (2012). High and Volatile Food Prices - FAO support to country level contingency planning. Rome IT

23. Rabobank (2011), Rethinking the F&A Supply Chain – impact of Agricultural Price Volatility on Sourcing Strategies. Rabobank International, Utrecht NL.
24. Escaler, M. and Teng, P. (2011). Mind the Gap: Reducing waste and losses in the food supply chain. NTS Insight June. RSIS Centre for Non-Traditional Security (NTS) Studies, Singapore.
25. Gordon, A. and Woodhill, J. (2012). Raising the bar: what is global food and agri-business saying about their sustainability goals? Ccontribution by the Wageningen UR Centre for Development Innovation to the From Islands of Success to Seas of Change (http://edepot.wur.nl/211518)
26. Wigboldus, (S.) and Lee, J. van der (2011). Going for gold in innovation partnerships responsive to food insecurity in Africa – the role of knowledge institutes. Volume 1: context study. Wageningen UR Centre for Development Innovation, Wageningen (NL).
27. Steenhuijsen Piters, B. de (2011) Naar 'mobile' kennis. From The Broker – connecting worlds of knowledge. IDP Leiden.
28. Eenhoorn, J.W., Graaf, K. van der & Schilpzand, R. (2012). 1-2-1 Food Losses Initiative; analysis of perception , initiatives and suggestions for reducing food losses in Ethiopia, Kenya and Uganda. (not published)
29. Topsector Agro&Food (2012). Innovatiecontract 2012 versie 2.1: Agro&Food: De Nederlandse Groeidiamant. (www.top-sectoren.nl/agrifood/sites/default/files/documents/Innovatiecontract%20AgroFood%2021_DEF_22032012.pdf)

Acronyms and abbreviations

AU	African Union
AfDB	African Development Bank
APEC	Asian Pacific Economic Co-operation
ADB	Asian Development Bank
BRICS	Brazil, Russian Federation, India, China, South Africa
CDI	Centre for Development Innovation
DC	Developing country
EIU	Economist Intelligence Unit
FAO	Food and Agriculture Organisation
FBR	Food & Biobased Research
FMO	Nederlandse Financieringsmaatschappij voor Ontwikkelingslanden NV
FSC	Fresh Supply Chain
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IDB	Interamerican Development Bank
IFAD	International Fund for Agricultural Development
IFC	International Finance Co-operation
IFI	International Finance Institution
IMF	International Monetary Fund
KIT	Royal Tropical Institute
LDC	Least Developed Countries
LEI	Dutch Agricultural Economic Institute
MDB	Multilateral Development Bank
MFI	Multilateral Finance Institution
NoE	Network of Excellence
OVO	Dutch abbreviation for the coherent structure between research, extension and education
PH	Postharvest
PHL(s)	Postharvest loss(es)
RNE	Royal Netherlands Embassy
SDC	Swiss Agency for Development and Cooperation
SFC	Sustainable Food Chain
UN	United Nations
USAID	United States Agency for International Development
WUR	Wageningen University and Research centre

Appendices

Appendix 1 - References used in the literature review

1. Acedo, A., K. Weinberger, R. J. Holmer and J. d'Arros Hughes (2012). Postharvest research, education and extension: AVRDC – the world vegetable center's experience. Asia Pacific Symposium on Postharvest Research, Education and Extension, Bangkok, Thailand, Acta Horticulturae.
2. Ahsan, H. (2004). Country paper India. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 131-142
3. Aked, J., H. Wainwright, D. Rees and A. Westby (2000). A review of the postharvest research issues for cooking banana, and plantani with specific reference to gahna, nigeria, Uganda and Tanzania. J. Wainwright, Acta Hort. 540: 529-537.
4. Akinyemi, S. O. S., I. O. O. Aiyelaagbe and E. Akyeampong (2010). Plantain (*Musa* spp.) cultivation in Nigeria: a review of its production, marketing and research in the last two decades, Acta Horticulturae. 879: 211-218.
5. Amorim, L., M. C. Martins, S. A. Lourenço, A. S. D. Gutierrez, F. M. Abreu and F. P. Gonçalves (2008). "Stone fruit injuries and damage at the wholesale market of São Paulo, Brazil." Postharvest Biology and Technology 47(3): 353-357.
6. Ansari, N. A. and H. Feridoon (2008). Postharvest applciation of hot water, fungicide and waxing on the shelf life of Valencia and the local orange cv. Siavarz, Acta Horticulturae. 768: 271-277.
7. Appiah, F., P. Kumah and E. A. Odame (2010). "Postharvest handling activities of cabbage (Brassica oleracea var capitata), carrot (Daucus carota) and garden eggs (Solanum melongena) in Kumasi, Ghana." Ghana Journal of Horticulture 8: 78-84.
8. Asiedu, S. K. (2003). Reducing postharvest losses: a training module development for West Africa, Act Horticulturae. 628: 69-72.
9. Atanda, S. A., P. O. Pessu, S. Agoda, I. U. Isong and I. Ikotun (2011). "The concepts and problems of post-harvest food losses in perishable crops." African Journal of Food Science 5(11): 603-613.
10. Awaidah, M. (2010). Postharvest losses of tomatoes and eggplants produced for local markets in Jordan. AARDO Workshop on technology on reducing post-harvest losses and maintaining quality of fruits and vegetables, Jordan.
11. Badrud-doza, A.F. (2005). Country paper Bangladesh. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 103-110
12. Baghkhandan, M.S. (2005). Country paper Islamic Republic of Iran. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 169-174

13. Bancroft, R. D., D. Crentsil, J. Y. Panni, F. Aboagye-Nuamah and L. Krampa (2005). The influence of postharvest conditioning and storage protocils of rots in white yams in Ghana, Acta Horticulturae. 682: 2183-2190.
14. Barry, I. N., H. Jaenicke, D. Virchow and G. N. Pichop (2009). Production and marketing of African indigenous vegetables in the Arumeru district of Tanzania: assessing postharvest loss and processing potential, Acta Horticulturae. 806: 481-488.
15. Bartels, P. (2008). Development of appropriate processing technology for fruit export by smallholder farmers. Report 990, Wageningen UR Agrotechnology and Food Sciences Group.
16. Beddington J, Asaduzzaman M, Clark M, Fernandez A, Guillou M, Jahn M, Erda L, Mamo T, Van Bo N, Nobre CA, Scholes R, Sharma R, Wakhungu J. 2012. Achieving food security in the face of climate change: Final report from the Commission on Sustainable Agriculture and Climate Change. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at:www.ccafs.cgiar.org/commission
17. Boateng, P. (2001). Losses and waste in the food chain. Rome, Italy, FAO.
18. Boonyakiat, D. (2003). Postharvest handling of vegetables in the royal project foundation, Acta Horticulturae. 604: 625-630.
19. Boselie, D., Jonker, M., Jonker, T., Poort, E. van der (2001). Improving the performance of agro supply chains in Asia. Report no. B539, Wageningen UR ATO B.V. (4 ref's)
20. Buntong, B., V. Srilaong and T. Wasusri (2010). "Current Supply Chain of Tomato in Cambodia." Acta Horticulturae 943: 259-263.
21. Buzby, J. C. and J. Hyman (2012). "Total and per capita value of food loss in the United States." Food Policy 37(5): 561-570.
22. Buzby, J. C. and H. F. Wells (2009). Supermarket loss estimates for fresh fruit, vegetables, meat, poultry, and seafood and their use in the ERS loss-adjusted food availability data, USDA.
23. Chanthasombath, T. and V. Srilaong (2010). "Current Supply Chains of Cabbage in Lao PDR." Acta Horticulturae 943: 265-270.
24. Charles, H., Godfray, J., e. a. (2010). "Food Security: The Challenge of Feeding 9 Billion People."
25. Venkatarayappa Chikkasubbanna (2004). Country paper India. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 143-151
26. Choudhury, M. L. (2006). Recent Developments in Reducing Postharvest Losses in the Asia-Pacific Region. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 15-22.
27. CTA (2011). "Post-harvest management: adding value to crops." Spore(152): 13-17.

28. Dobbs, R., J. Oppenheim, F. Thompson, M. Brinkman and M. Zornes (2011). Resource revolution: meeting the world's energy, materials, food and water needs. M. G. Institute.
29. Eenhoorn, H. & Becx, G. (2009). Constraints Constraints! Wageningen UR.
30. FAO (2011). Food loss reduction strategy, FAO.
31. FAO (2012). Food loss prevention for improving food security in the near east. FAO Regional Conference for the Near East, Rome, Italy, FAO.
32. Fehr, M. and D. C. Romao (2001). "Measurement of fruit and vegetable losses in Brazil: a case study." Environment, Development and Sustainability 3(3): 253-263.
33. FFTC (2012). Postharvest Losses of Fruit and Vegetables in Asia. Extension Bulletin / Food & Fertiliser Technology Center, FFTC. 2012.
34. Fonseca, J. M. and D. N. Njie (2012). Addressing Food Losses due to Non-Compliance with Quality and Safety Requirements in Export Markets: the case of Fruits and Vegetables from the Latin America and the Caribbean Region. International Conference of Agricultural Engineering CIGR-AgEng 2012.
35. Foresight (2010). "Expert forum on the reduction of food waste." Government Office for Science , London. (4 ref's)
36. Foresight (2011). The Future of Food and Farming. Final Project Report. The Government Office for Science, London.
37. World Economic Forum (2009). Driving Sustainable Consumption - Value Chain Waste.
38. Gajanana, T. M., M. Sudha, A. K. Saxena and V. Dakshinamoorthy (2010). "Postharvest handling, marketing and assessment of losses in papaya." Acta Horticulturae 851: 519-526.
39. Goletti, F. (2003). Current status and future challenges for the postharvest sector in developing countries. XXVI International Horticultural Congress: Issues and Advances in Postharvest Horticulture. Toronto, Canada, Acta Horticulturae: 41-48.
40. Gustavsson, J., C. Cederberg and U. Sonesson (2011). Global food losses and food waste: extent, causes and prevention, FAO. (3 ref's)
41. Haryanto, B., Royaningsih, S., Henanto, H. (2004). Country paper Indonesia. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 152-157
42. Haryanto, B., Rochani, A. (2004). Country paper Indonesia. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 158-163
43. Herregods, M. (1998). Post-harvest of horticultural crops, International Society for Horticultural Science.
44. Hewett, E. W. (2008). Maximizing quality of fresh produce: a challenge for postharvest eduction programs, Acta Horticulturae. 804: 31-38.
45. Hewett, E. W. (2012). Postharvest technology innovation and opportunities of extension

for horticultural produce: perspective and trends. Acta Horticulturae: 25-32.

46. Hodges, R. J. and M. Bernard (2010). "African Postharvest Losses Information System–a network for the estimation of cereal weight losses." Julius-Kühn-Archiv 245(Proceedings of the 10th International Working Conference on Stored Product Protection): 956-962.
47. Hoogerwerf, A., Jonker, J.M.E. en Poort, E.S. van der (2001). Value Added Centres (VAC) – Final Report on the Main Phase: Design and ex ante evaluation of a VAC network for fruits and vegetables in Gujarat. Report B 524 Wageningen UR ATO B.V.
48. Huang, C.C. (2004). Country paper Republic of China. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 117-122
49. Ilic, Z. S., P. Vukosljevic and V. Zaric (2012). Cold chain strategy for Serbia. International Symposium on Postharvest Technology in the Global Market. Lisbon, Portugal, Acta Horticulturae: 89-96.
50. Jabir, A. (2012). "Factors influencing adoption of postharvest practices in vegetables." International Journal of Vegetable Science 18(1): 29-40.
51. Javanmard, M. (2009). A SWOT analysis of organic grapefruit production in Iran, Acta Horticulturae. 831: 319-326.
52. Joshi, P. K., N. P. Singh, R. V. Gerpacio and P. L. Pingali (2005). Maize in India - production systems, constraints and research priorities. Mexico, CIMMYT.
53. Jowkar, M. M. (2005). The importance of horticultural extension in reducing post-harvest losses in Iran, Acta Horticulturae. 672: 171-175.
54. Jowkar, M. M., Z. Farshadfar, H. Mohammadpour and A. Jowkar (2005). A look at postharvest in Iran, Acta Horticulturae. 682: 2177-2182.
55. Kader, A. A. (2005). Increasing food availability by reducing postharvest losses of fresh produce. Proceedings of the 5th International Postharvest Symposium, Vols 1-3.
56. Kader, A. A. (2010). Handling of horticultural perishables in developing vs. developed countries, Acta Horticulturae. 877: 121-126.
57. Kader, A. A., K. Lisa, A. M. Hussein, O. Abdin, A. Jabarin and A. E. Sidahmed (2012). Role of Agro-industry in Reducing Food Losses in the Middle East and North Africa Region. Cairo, Egypt, FAO. (10 ref's)
58. Kitinoja, L. and H. Y. AlHassan (2012). Identification of appropriate postharvest technologies for small scale horticultural farmers and marketers in Sub-Saharan Africa and South Asia, Acta Horticulturae. 934: 31-40.
59. Kitinoja, L., S. Saran, S. K. Roy and A. A. Kader (2011). "Postharvest technology for developing countries: challenges and opportunities in research, outreach and advocacy." Journal of the science of food and agriculture 91(4): 597-603.
60. Kshirsagar (2005). Farmers' use of postharvest infrastructure facilities for fruits and vegetables in India: present problems and future strategies, Acta Horticulturae. 682: 2199-

2206.

61. Virendra Kumar (2004). Country paper Fiji. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 123-130

62. Lans, C. van der, Snoek, H., Boer, F. de, Elings, A. (2012). Vegetable chains in Kenya; production and consumption of vegetables in the Nairobi metropolis. Rapport GTB-1130, Wageningen UR Greenhouse Horticulture.

63. Liu, F. W. (2012). "Postharvest Handling in Asia 2. Horticultural Crops." Extension Bulletin / Food & Fertilizer Technology Center, 2012, from http://www.fftc.agnet.org/library.php?func=view&style=type&id=20110715234145.

64. Lundqvist, J., C. de Fraiture and D. Molden (2008). "Saving water: from field to fork." 36.

65. Maheswar, C. and T. S. Chanakya (2006). Postharvest losses due to gaps in cold chain in India - a solution, Acta Horticulturae. 712: 777-784.

66. Manalili, N. M. (2011). "Appropriate food packaging solutions for developing countries." 37.

67. Mao, M. (2004). Country paper Cambodia. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 111-116

68. Mashau, M. E. (2012). "Assessment of postharvest losses of fruits at Tshakhuma fruit market in Limpopo Province, South Africa." African Journal of Agricultural Research 7(29): 4145-4150.

69. McIntyre, B.D., Herren, H.R., Wakhungu, J., Watson, R.T. (eds.) (2009). Agriculture at a Crossroads. International Assessment of Agricultural Knowledge, Science and technology for Development (IAASTD), Washington DC, USA. (2 ref's)

70. Mhlanga, N., E. Seidler, D. Njie and S. Gallat (2010). Reducing Post-harvest losses. Lessons learned and practical guidelines to address post-harvest losses in grain supply chains in Africa. Rome, Italy, FAO.

71. Mitra, S. K. (2008). Harvesting, packaging, transportation and marketing of tropical fruits in West Bengal, India: present practice and future needs, Acta Horticulturae. 768: 301-306.

72. Mittal, S. (2007). "Strengthening Backward and Forward Linkages in Horticulture: Some Successful Initiatives." Agricultural Economics Research Review 20(2007): 457-469.

73. Moghaddasi, R., Elaheh, M., Shariati, S. (2005). Country paper Islamic Republic of Iran. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 164-168

74. Najafi, B. (2005). New roles of government in improving fruit and vegetable marketing at national and local levels. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 70-79

75. Nehvi, F. A., S. A. Wani, S. A. Dar, M. I. Makhdoomi, B. A. Allie and Z. A. Mir (2007).

"New emerging trends on production technology of saffron." Acta Horticulturae 739: 375-381.

76. Oelofse, S. H. H. and A. Nahman (2012). "Estimating the magnitude of food waste generated in South Africa." Waste management & research Epub Ahead.
77. Olorunda, O. A. (2000). Recent advances in postharvest technologies of banana and plantain in Africa, Acta Hort. 540: 517-527.
78. Oyewole, B. A. and S. A. Oloko (2006). "Agricultural and food losses in Nigeria - the way out." International Journal of Rural Studies 13(1): 14-16.
79. Parfitt, J. (Resource futures), M. B. W. (2011). "Food waste reduction: a global imperative." 6.
80. Parfitt, J. (Resource futures), M. B. W. (2011). "Global food waste reduction: priorities for a world in transition." 44.
81. Parfitt, J., M. Barthel and S. Macnaughton (2010). Food waste within food supply chains: quantification and potential for change to 2050, Philosphical Transactions of the Royal Society - Biological Sciences: 3065-3081.
82. Patil, R. T. (2010). Appropriate engineering and technology interventions in horticulture for enhanced profitability and reduction in postharvest losses, Acta Horticulturae. 877: 1363-1369.
83. Paull, R. E. and N. J. Chen (2005). "The Potential of Postharvest Technologies to Maintain Quality." Acta Horticulturae 694: 377-385.
84. Prusky, D. (2011). "Reduction of the incidence of postharvest quality losses, and future prospects." Food Security 3(4): 463-474.
85. Rahim, M. A., M. A. Kabir, M. A. Hossain, F. Islam and N. Naher (2008). Present status of quality management in postharvest system for fruit in Bangladesh, Acta Horticulturae. 804: 623-630.
86. Redlingshöfer, B. and A. Soyeux (2012). Food losses and wastage as a sustainability indicator of food and farming systems. The 10th European IFSA Symposium : Producing and reproducing farming systems. New modes of organisation for sustainable food systems of tomorrow.
87. Rolle, R.S. and F. Mazaud (2003). Toward a global initiative for post-harvest development. XXVI International Horticultural Congress: Issues and Advances in Postharvest Horticulture. Toronto, Canada, Acta Horticulturae: 49-53.
88. Rolle, R.S. (2006). Improving Postharvest Management and Marketing in the Asia-Pacific Region: Issues and Challenges. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 23-31
89. Rolle, R.S. (2006). Processing of Fruits and Vegetables for Reducing Postharvest Losses and Adding Value. From: Postharvest Management of Fruit and Vegetables in the Asia

Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 32-42

90. Saran, S., S. K. Roy and L. Kitinoja (2012). Appropriate postharvest technologies for small scale horticultural farmers and marketers in Sub-Saharan Africa and South Asia - Part 2., Acta Horticulturae. 934: 41-52.

91. Sharma, S. K., M. C. Nautiyal and K. Issar (2011). Postharvest rotting, quality and shelf life of apple as affected by chemicals, GA treatment and packaging, Acta Horticulturae. 905: 201-209.

92. Snels, J.C.M.A. and Westra, E.H. (2009). Sustainable conventional and organic vegetable flow to Europe: Supply Chain Optimization. Report 1104, Wageningen UR Food & Biobased Research.

93. Snels, J.C.M.A. and Westra, E.H. (2008). Export from Argentina to Europe: Getting Across. Start up of a sustainable vegetable and fruit trade flow from Argentina to Europe. Report 891, Wageningen UR Agrotechnology and Food Sciences Group.

94. Snels, J. (ed.) et al. (2010). Bottlenecks in Thai Agro Logistics. Report 1106-A. Wageningen UR Food & Biobased Research.

95. Sirivatanapa, S. (2004). Packaging and Transportation of Fruits and Vegetables for Better Marketing. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 43-48

96. Skrupskis, I., A. Aboltins and U. Iljins (2010). "Parameters of Storage Process Influencing Vegetable Quality." Acta Horticulturae 858: 83-88.

97. Tefera, T. (2012). "Post-harvest losses in African maize in the face of increasing food shortage." Food Security 4(2): 267-277.

98. Tongdee, S. C. (2012). Horticultural Crop Production and Marketing Decision Influencing Postharvest Technology. Extension bulletin / Food & Fertiliser Technology Center, FFTC. 2012.

99. Tongtao, S., V. Srilaong, T. Wasusri, P. Boonyaritthongchai and S. Kanlayanarat (2012). Supply chain management of rambutan fruit for export in Chanthaburi province, Bangkok, Thailand, Acta Horticulturae.

100. Udas, S., B. K. Rai, M. Gurung, R. Thapa and P. P. Khatiwada (2005). Assessment of postharvest handling systems of vegetables in the Eastern hills of Nepal, Acta Horticulturae. 682: 2191-2198.

101. Vinning, G.S., Young, J. (2006). Linking production and marketing of fruit and vegetables for better farm incomes in the Asia-Pacific region. From: Postharvest Management of Fruit and Vegetables in the Asia Pacific Region (eds. R.S. Rolle). Asian Productivity Organisation, Tokyo 2006: 49-69

102. Weinberger, K., G. C. Il and A. Acedo (2008). Quantifying postharvest loss in vegetables along the supply chain in Vietnam, Cambodia and Laos, Int. J. Postharvest Technology and Innovation. 1: 288-297. (3 ref's)

103. Westra, E.H. (2008). Fact-finding Mission: Melon Quality in the US Supply Chain Screening postharvest handling of Caribbean Gold RZ melons. Report 1019, Wageningen UR Agrotechnology and Food Sciences Group.
104. Wiersinga, R. C., J. Snels and L. Admiraal (2008). Prospects and challenges for refrigerated container transport of fruits and vegetables from Ethiopia to the Middle East. Wageningen, Wageningen UR EI & AFSG.
105. Wilson, L. G. (2010). Current status and future outlook of the global horticulture and postharvest initiatives. VI International Postharvest Symposium. Antalya, Turkey, Acta Horticulturae: 47-54.
106. Yahia, E. M. (2005). "Postharvest research and reality in developing countries." Acta Horticulturae 682: 1655-1666.
107. Yahia, E. M. (2010). Cold chain development and challenges in the developing world. VI International Postharvest Symposium, Antalya, Turkey, Acta Horticulturae.

Appendix 2 - Matrix causes postharvest food losses

excerpt of inventory matrix

28	Addressing Food Losses due to Non-Compliance with Quality and Safety Requirements in Export Markets: the case of Fruits and Vegetables from the Latin America and the Caribbean Region	Fonseca, J.M., Njie, D.N.	2012	Latin America and Carribean region (LAC)	fruit and vegetables pineapple mango papaya	storage capacity per country ! 17% 21% 58%	 retail USA retail USA retail USA	22	*storage*	The situation in airports is even worse as in many cases cold facilities are	*market information*		*packaging*		*credit access*		*transport climate control*		*relations in business #1*		*seeds*	
									road quality	quality of roads: In some LAC rural areas with significant agricultural production the roads frequently become impassable to vehicular traffic during the rainy season	*chain length*	losses of LAC products are high both within the producing countries as well as in international markets	*grading & sizing*		*investment analysis*	Lack of investment in technology for agro-industry has been identified as a major obstacle for economic development. The problem is most noticeable in developing countries including the LAC region where the presence of an ideal environment for mobilizing private	*cold chain*	- in comparison to industrialized countries, cold chain capacity in the region is still relatively low - impact of cold chain breaks	*available services*		*crop protection*	
									connec-tivity		*pricing*		*quality control*		*economies of scale*		*climate*		*education and R&D #1*	lack of knowledge to understand the relationship between final quality and various combinations of handling failures; lack of knowledge to forecast variability in quality at harvest, regardless of the	*water*	
									distances		*standards in quality and service #1*	postharvest losses due to non-compliance with trade regulations and buyers' demands in international markets continue to occur.Among rejected vegetables the number one violation was the presence of pesticides	*(PH) product handling #1*	attention must also be given to the improvement of the handling practices along the postharvest chain; The pineapple case suggests that the high volume (i.e. exceeding 25% of consignment) of fruits reaching destination markets with quality defects is likely the result of	*production costs*				*structure / type of organisatio n*			
									energy	In the Dominican Republic, only one of the nine seaports which handle horticultural products has electrical power supply in	*facilities *)*		*processing*						*Social / cultural*			
											hygiene	filthy product	*biological causes*						*Role of governeme nt*			
											labelling & branding	no registration of the manufacturers	*equipments*									
											logistics	The second most detected violation was the lack of process in file	*maintenanc e*									
29	Driving Sustainable Consumption - Value Chain Waste	World Economic Forum	2009	developing countries	food	26-40%	pre-harvest	48	*storage*	- inadequate storage facilities	*market information*		*packaging*		*credit access*	lack of financial resources to implement sustainability	*transport climate*	poor transport	*relations in business*		*seeds*	
						10-50%	post-harvest		*road quality*		*chain length*		*grading & sizing*		*investment analysis*		*cold chain*		*available services*		*crop protection*	
						0-10%	consump-tion		*connec-tivity*		*pricing*		*quality control*		*economies of scale*		*climate*	adverse climate with high humidity and temperature	*education and R&D*		*water*	
									distances		*standards in quality and service*		*(PH) product*		*production costs*				*structure / type of*			
									energy		*facilities *)*		*processing*	inefficient processing					*Social / cultural*			
											hygiene		*biological causes*						*Role of governeme*			
											labelling & branding		*equipments*									
											logistics		*maintenanc e*									

Appendix 3a - Interview script

(Dutch language only)

Section 1. Profiel en informatie bedrijf / organisatie

Naam bedrijf / organisatie	:	
Type bedrijf / organisatie	:	☐ producent ☐ importeur / inkooporganisatie ☐ leverancier technologie ☐ groothandel / retail ☐ financiële dienstverlening ☐ consultancy ☐ kennisinstelling ☐ non-gouvernementele organisatie ☐ anders, nl. … … …
Korte beschrijving	:	
Naam geïnterviewde functionaris	:	
Functie binnen de organisatie	:	
Adres- en contactgegevens	:	

Vraag 1.	*In welke lage-lonen landen en opkomende markten is uw bedrijf actief? [als exporteur (goederen/diensten), agentschap, vertegenwoordiging, eigen vestiging]*
Vraag 2.	*In welke agrofood sectoren bent u actief?*
Vraag 3.	*Wat zijn uw belangrijkste afzetmarkten / klanten, nu en verwachting voor de nabije toekomst?*

Vraag 4.	*Kunt u aangeven voor welke landen post-harvest voedselverliezen een probleem zijn, in de zin dat grote verliezen ontstaan in de fase tussen oogst en consumptie?*
Vraag 5.	*Voor welke productcategorieën geldt dit?*

Section 2. Post-harvest voedselverliezen: oorzaken, effecten en obstakels

Vraag 6.	*Vanuit uw ervaring: zijn er specifieke punten in de post-harvest productieketen aan te wijzen waar de grootste voedselverliezen plaatsvinden? Welke zijn dit?*
Vraag 7.	*Wat zijn op grond van uw ervaringen de oorzaken waardoor verliezen in de post-harvest keten ontstaan? Graag toelichten voor landen, die van toepassing zijn, waarbij de volgende categorieën worden onderscheiden:*
• *Technologie* • *infrastructuur* • *Service / ondersteuning* • *Voorlichting* • *Organisatie / management* • *Training / opleiding* • *Markttoegang* • *Marktinformatie* • *Financiering* • *Ondersteuning overheid* • *Kwaliteitseisen / standaardisatie*	
Vraag 8.	*Heeft u inzicht in wat er met de producten die in de keten verloren gaan gebeurt?*

Vraag 9.	*Wat zijn op grond van uw ervaringen in de genoemde landen vanuit het perspectief van uw bedrijf belemmeringen of obstakels bij het ontwikkelen en implementeren van oplossingen voor voedselverliezen in de post-harvest keten? Graag toelichten voor de categorieën en landen, die van toepassing zijn.*

• *Technologie* • *infrastructuur* • *Service / ondersteuning* • *Voorlichting* • *Organisatie / management* • *Training / opleiding* • *Markttoegang* • *Marktinformatie* • *Financiering* • *Ondersteuning overheid* • *Kwaliteitseisen / standaardisatie*	

Section 3. Oplossingen voor de reductie van post-harvest voedselverliezen

Vraag 10.	*Welke maatregelen moeten er volgens u worden genomen om oplossingen te kunnen realiseren voor de reductie van post-harvest voedselverliezen?*
Vraag 11.	*Kent u (succesvolle) voorbeelden van deze maatregelen?*
Vraag 12.	*Ziet u daarin een rol voor uw bedrijf en welke oplossingsrichtingen onderscheidt u daarin?*
Vraag 13.	*Wie of wat heeft u nodig om deze maatregelen door te kunnen voeren?*

Section 4. Samenwerking in de keten & kennisontwikkeling

Vraag 14.	*Werkt uw organisatie samen met ander partijen in de keten om projecten te realiseren die gericht zijn op het voorkomen van voedselverliezen in de post-harvest keten? Kunt u dit toelichten?*
Vraag 15.	*Welke rol heeft uw bedrijf in deze samenwerking (regisseur / initiatiefnemer / leverancier)*
Vraag 16.	*Beschikt uw bedrijf over voldoende kennis om de problematiek van post-harvest voedselverliezen aan te pakken?*
Vraag 17.	*Waaruit bestaat die kennis en welke instrumenten heeft u tot uw beschikking?*
Vraag 18.	*Welke kennis / informatie heeft u nodig?*

Section 5. Ondersteuning in de uitvoering van maatregelen

Vraag 19.	*Heeft u belangstelling voor deelname aan een 'virtual network of excellence agrologistics' met de specifieke doelstelling reductie van post-harvest voedselverliezen? Waarom?*
Vraag 20.	*Op welke begunstigde partijen zou het netwerk zich moeten richten? Met ander woorden: wie vormen de doelgroep van het netwerk?*
Vraag 21.	*Wat zijn voor u randvoorwaarden voor deelname in het netwerk?*
Vraag 22.	*Wat zou voor u de meerwaarde kunnen/moeten zijn voor deelname aan het netwerk?*

Vraag 23.	*Welke partijen zouden volgens u deel uit moeten maken van het netwerk?*
Vraag 24.	*Welke organisatievorm zou het netwerk moeten hebben? (e.g. profit / non-profit, stichting, vereniging, vennootschap, coöperatie?)*
Vraag 25.	*Heeft u specifieke verwachtingen u ten aanzien van het ministerie van EZ, en zo ja welke? (i.c. instrumentarium m.b.t. handelsbelemmeringen, financiële ondersteuning, communicatie)*
Vraag 26.	*Heeft u suggesties voor andere partijen die we bij dit onderzoek en het ontwikkelen van het 'network of excellence' zouden kunnen betrekken?*

Appendix 3b - Overview of potential stakeholders

PRD	**Vegetable & fruit production / import**
PRD1	Van Oers United
PRD2	Hagé International
PRD3	Tropical Fresh Ltd.
PRD4	Staay Food Group
IMP	**Wholesale / import**
IMP1	Eosta
IMP2	Bakker Barendrecht
IMP3	Smeding
IMP4	AgroFair
IMP5	Jaguar The Fresh Company
IMP6	Olympic Fruit Group
IMP7	Tradin Organic Agriculture
IMP8	Langfruit
IMP9	Best Fresh Group
IMP10	AJB's Fruitbox
IMP11	SFI Rotterdam
IMP12	Hillfresh International
IMP13	Nature's Pride
SUP	**Product sourcing / import**
SUP1	Spar International
SUP2	Koninklijke Ahold / Albert Heijn
SUP3	ICASS Persihable Sourcing Europe
SUP4	Metro cash & Carry Nederland
SUP5	Superunie
PRC	**F&V processors**
PRC1	SVZ International
PRC2	Africa Juice
TEC	**Technology supply**
TEC1	GMV-FME
TEC2	Geerlofs Koeltechniek
TEC3	GEA refrigeration Netherlands
TEC4	Celtic Cooling
TEC5	Frigo Breda
TEC6	Besseling Group
TEC7	Fresh Food Technology
TEC8	Van Amerongen CA Technology
TEC9	J. van der Put Fresh Cargo Handling
TEC10	Holland Perishable Center
TEC11	Sensitech Europe, Middle East & Africa (EMEA)
TEC12	AWETA
TEC13	Greefa
TEC14	eLEAF
TEC15	Florigo
CON	**Consultancy**
CON1	Adviesbureau Verhoef
CON2	Berenschot Groep
CON3	TeamPro
CON4	FairMatch
CON5	CREM
CON6	AFAFO
CON7	The Partnership Resource Centre
CON8	FlowerWatch
FIN	**Finance**
FIN1	OIKO Credit
FIN2	Care
FIN3	FMO
FIN4	InReturn BV
FIN5	Rabobank Foundation
FIN6	Triodos Bank Nederland
FIN7	Triodos Bank International
FIN8	ASN Foundation
FIN9	Triodos Facet
TRD	**Trade organisations**
TRD1	Netherlands African Business Council
TRD2	Netherlands-Indian Chamber of Commerce
NGO	**Non-governmental organisations**
NGO1	Agri-Profocus
NGO2	Oxfam-Novib
NGO3	SNV
NGO4	ICCO
NGO5	Agriterra
NGO6	Agromisa
NGO7	Cordaid
NGO8	Hivos
NGO9	Solidaridad
KNI	**Knowledge institutes**
KNI1	LEI
KNI2	CDI
KNI3	PPO Akkerbouw
KNI4	PPO Fruit
KNI5	Koninklijk Instituut voor de Tropen
KNI6	International Institute of Social Studies
KNI7	PTC+
KNI8	Farmer Field School Foundation
KNI9	CTA
KNI10	TNO
KNI11	RIKILT
KNI12	FBR
KNI13	Alterra
KNI14	Dinalog
RNE	**Royal Netherlands Embassies**
RNE1	Roemenië, Bulgarije
RNE2	Brazilië
RNE3	Egypte
RNE4	Oekraïne
RNE5	Rwanda
RNE6	Rusland, Kazachstan
RNE7	Zuid-Afrika, Mozambique, Angola
RNE8	Argentinië, Chili, Uruguay, Paraguay
RNE9	Kenia, Oeganda, Tanzania
RNE10	Ethiopië
RNE11	India, Sri Lanka, Nepal
RNE12	Indonesië, Singapore, Maleisië
RNE13	Thailand, Vietnam
RNE14	China
RNE15	South Korea
OTH	**Other**
OTH1	CBI
OTH2	Metropolitan Food Security
OTH3	World Connectors / 1-2-1

Appendix 3c - questionnaire agricultural departments RNEs

Questionnaire on the reduction of post-harvest food losses

Introduction

This questionnaire is part of a research on the feasibility of a virtual network of excellence agrologistics to reduce post-harvest food losses. This research is executed by the DLO-institutes Food & Biobased Research (FBR) and the Agricultural Economics Research Institute (LEI) of Wageningen UR, thereto contracted by the Ministry of EL&I.

The objective of the research project is to establish the feasibility for the development of a virtual network of excellence that will contribute to the reduction of post-harvest food losses. The project will attempt to answer the following questions:

- Is it feasible to establish a virtual network of excellence agrologistics with parties that can have a positive impact on the reduction of post-harvest food losses?
- What is the organisational profile of such a virtual network?

Definitions and project boundaries

Food losses:	Refers to the decrease in food quantity or quality, which makes it unfit for human consumption. In most cases this occurs as a result of untimely or improper methods of harvest, storage, distribution, processing, transport, sales or consumption.
Post-harvest:	Crop handling, transport, post-harvest operations, drying, storage, primary/secondary processing, product evaluation (quality control), packaging, wholesale/retail marketing, distribution.
Product:	• Vegetables and fruits (primary) • Dairy (secondary)
Countries of investigation:	Low-income countries and emerging markets
Centre of excellence:	Conglomerate of parties that can have a specific contribution to the reduction of post-harvest losses.
Virtual:	Refers to a network structure which does not contain physical or personal assets. The network will be able to mobilise expertise from the specific partners of the centre on a case-by-case and project-basis.

Purpose of this questionnaire

1. To gain insight in the nature of post-harvest losses in the countries of investigation, specifically on vegetables, fruit and dairy.
2. To gain insight in the local knowledge partners that have or may have a role developing an infrastructure with knowledge/expertise on the reduction of post-harvest food losses.
3. To gain insight on the political agenda with regard to reduction of post-harvest losses.
4. To involve liaisons at the RNE's in the development of a network specifically targeted towards the reduction of post-harvest food losses.

The following questions apply to the countries that are part of your servicing area. In some questions the phrase is therefore posed as "in your countries" which refers to the countries that are included in your servicing area.
The questionnaire is divided into 4 sections:

Section 1: general information Royal Netherlands Embassy
Section 2: post-harvest losses in the countries: causes, effects and obstacles
Section 3: knowledge infrastructure on post-harvest food loss reduction
Section 4: political agenda on the reduction of post-harvest losses

Section 1. General information Royal Netherlands Embassy

Location	*:*		
Countries	*:*	Country A:	
		Country B:	
		Country C:	
		Country D:	
Representing official	*:*		
Position	*:*		
Contact details	*:*		

Section 2. Post-harvest losses in the countries: causes, effects and obstacles

Quest. 1 *Are post-harvest food losses considered as a problem in the countries that are served by your office? Please tick the boxes and add comment/ remark when appropriate.*

	Yes	**No**	**Comment / remarks**
Country A:	☐	☐	
Country B:	☐	☐	
Country C:	☐	☐	
Country D:	☐	☐	

Quest. 2 *Can you specify the problem of food losses in your countries for the following product categories in terms of gravity or seriousness of the problem (please tick on the boxes)*

Country: A	*Not serious*	*Slightly serious*	*Serious*	*Very serious*	*Extremely serious*
Vegetables & fruits	☐	☐	☐	☐	☐
Roots & tubers	☐	☐	☐	☐	☐

Dairy	☐	☐	☐	☐	☐
Meat	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐
Cereals	☐	☐	☐	☐	☐
Country: B	*Not serious*	*Slightly serious*	*Serious*	*Very serious*	*Extremely serious*
Vegetables & fruits	☐	☐	☐	☐	☐
Roots & tubers	☐	☐	☐	☐	☐
Dairy	☐	☐	☐	☐	☐
Meat	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐
Cereals	☐	☐	☐	☐	☐
Country: C	*Not serious*	*Slightly serious*	*Serious*	*Very serious*	*Extremely serious*
Vegetables & fruits	☐	☐	☐	☐	☐
Roots & tubers	☐	☐	☐	☐	☐
Dairy	☐	☐	☐	☐	☐
Meat	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐
Cereals	☐	☐	☐	☐	☐
Country: D	*Not serious*	*Slightly serious*	*Serious*	*Very serious*	*Extremely serious*
Vegetables & fruits	☐	☐	☐	☐	☐
Roots & tubers	☐	☐	☐	☐	☐
Dairy	☐	☐	☐	☐	☐
Meat	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐
Cereals	☐	☐	☐	☐	☐

PLEASE NOTE!! *The following questions 3-5 apply to the product categories vegetables, fruits and dairy*

Quest. 3	*What are considered the causes of post-harvest food losses incurred in the supply chain? More than one cause is possible.*
Fresh vegetables & fruits:	
Dairy:	

Quest. 4	*Can you indicate for the following supply chain links: what are considered <u>weak points in the supply chain</u> and in what way do these have an effect on the occurrence of post-harvest food losses?* *You may indicate multiple supply chain links when applicable. When a weak point is applicable to a specific country then please indicate so by ticking the boxes for country A, B, C and/or D:*	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Farm:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Grading & sorting of product:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Packaging:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Storage:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Transport** (from farm to wholesale market / wholesale market to retail)**:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Trade / wholesale markets:**	

A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Retail / detail / street markets:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Export:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Other: … … …**	

Quest. 5 *What are considered <u>obstacles or constraints</u> in solving the problem of post-harvest food losses? Please clarify, in which you can consider the following categories. If you want you can add additional categories.*

A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Technology:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Service / support:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Organisation / management:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Training / education:**	

A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Market access:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Market information:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Finance:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Public governance:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	**Standardisation / quality systems:**	
A: ☐ **B:** ☐ **C:** ☐ **D:** ☐	……	

Section 3. Knowledge infrastructure on post-harvest food loss reduction

Quest. 6	*Please indicate for each country which <u>institutes</u> are present that have or could have a role in building up a knowledge infrastructure on the subject of post-harvest losses in the fresh food supply chain? (R&D, training & education, extension services)*
Country A:	

Country B:	
Country C:	
Country D:	

Section 4. Political agenda on the reduction of post-harvest food losses

Quest. 7	*Is there a political agenda on reducing post-harvest food losses, as part of the country's agricultural and food policy (increasing or improving the country's self-sufficiency on food production or food security). And if yes, how would you phrase this agenda?*
Country A:	
Country B:	
Country C:	
Country D:	

Quest. 8	*Are you aware of any programmes or projects in the countries of your service, that are defined with the purpose to or aimed at reducing post-harvest food losses?*
Country A:	
Country B:	

Country C:	
Country D:	

Quest. 9	*Are these programmes or projects targeted towards fresh food products, in particular fresh fruits and vegetables and dairy products?*
Country A:	
Country B:	
Country C:	
Country D:	

We thank you very much for your efforts to provide us with the requested information for this research project. The results of this project are expected to be presented beginning 2013.

Appendix 4 - datasets postharvest losses fruit and vegetables

Table 1 Registered postharvest losses of individual crops, for categories fruits and vegetables, and for combinations of these

Src.	Region	Country	Category	Product	PHLs		
					from	until	mean
14	world		fruit & vegetables				20%
4	Africa	Ghana		banana			<10%
4	Africa	Nigeria		banana			<10%
4	Africa	Uganda		banana			<10%
4	Africa	Tanzania		banana			<10%
8	Africa	Ghana		cabbage			19%
8	Africa	Ghana		carrot			9%
9	Africa	Ghana	fruit & vegetables				50%
9	Africa	Gambia	fruit & vegetables				50%
12	Africa	Ghana		yam	20%	50%	35%
13	Africa	Tanzania		leafy vegetables			12%
13	Africa	Tanzania		eggplant			14%
43	Africa	Egypt	fruits				20%
43	Africa	Egypt	vegetables				30%
45	Africa	Egypt	fruits				19%
45	Africa	Egypt	vegetables				29%
45	Africa	Egypt		orange			14%
45	Africa	Egypt		tomato			15%
47	Africa	Rwanda	perishables		30%	80%	55%
47	Africa	Ghana	perishables		30%	80%	55%
47	Africa	Benin	perishables		30%	80%	55%
50	Africa		fruit, vegetables, roots & tubers				50%
53	Africa	South Africa	fruit				50%
59	Africa	South Africa	agriculture				30%
71	Africa		veg	cassave			45%
71	Africa		veg	yam			50%
81	Africa	Ethiopia	fruit & vegetables		25%	35%	30%
82	Africa	Ethiopia	fruit & vegetables		20%	60%	40%
119	Africa	Kenya	vegetables		20%	50%	35%
2	Asia		perishables		20%	50%	35%
3	Asia	Cambodja		leafy vegetables			10%
3	Asia	Laos		leafy vegetables			8%
3	Asia	Vietnam		leafy vegetables			6%
16	Asia	Thailand		lettuce			11%
16	Asia	Thailand		chinese cabbage			13%
16	Asia	Thailand		cabbage			8%
16	Asia	Thailand		sweet corn			5%
16	Asia	Thailand		michilli cabbage			10%
16	Asia	Thailand		pumpkin			9%
16	Asia	Thailand		carrot			30%
16	Asia	Thailand		cos lettuce			16%
16	Asia	Thailand		zucchini			7%
16	Asia	Thailand		cucumber			2%
16	Asia	Thailand		bean			7%
16	Asia	Thailand		red cabbage			4%
16	Asia	Thailand		celery			6%
16	Asia	Thailand		tomato			6%
16	Asia	Thailand		cherry tomato			4%
16	Asia	Thailand		onion			7%
16	Asia	Thailand		chayote			2%
16	Asia	Thailand		egg plant			5%
16	Asia	Thailand		spinach			24%
16	Asia	Thailand		red leaf lettuce			17%
17	Asia	Cambodia		tomato	2%	5%	4%
18	Asia	Lao		cabbage	16%	18%	17%
22	Asia	India	fruit & vegetables		10%	40%	25%
26	Asia	Iran	fruit & vegetables		35%	70%	53%
26	Asia	Iran		tomato			17%

Table 1 continued

Src.	Region	Country	Category	Product	PHLs		
					from	until	mean
26	Asia	Iran		cucumber			21%
26	Asia	Iran		figs			20%
26	Asia	Iran		grapes	16%	23%	19%
26	Asia	Iran		dates			15%
30	Asia	India		papaya			26%
38	Asia	India	vegetables		20%	30%	25%
47	Asia	India	perishables		30%	80%	55%
50	Asia	India	fruit & vegetables				30%
51	Asia	India	fruit & vegetables				30%
56	Asia	India	fruit		25%	30%	28%
61	Asia	China		potato			28%
61	Asia	China		pear			22%
61	Asia	China		apple			15%
61	Asia	China		papaya			25%
61	Asia	China		chinese cabbage			25%
61	Asia	China		lettuce			32%
61	Asia	China	fruit				37%
61	Asia	China	vegetables				46%
61	Asia	Poland	apple				20%
70	Asia	Bangladesh	fruit		20%	25%	23%
70	Asia	Bangladesh		banana			20%
70	Asia	Bangladesh		papaya			46%
70	Asia	Bangladesh		pineapple			18%
70	Asia	Bangladesh		lime			40%
70	Asia	Bangladesh		beans			30%
70	Asia	Bangladesh		carrot			25%
70	Asia	Bangladesh		cabbage			25%
70	Asia	Bangladesh		tomato			40%
70	Asia	Bangladesh		okra			46%
70	Asia	Bangladesh		eggplant			20%
74	Asia	India		apple			14%
75	Asia	India	fruit & vegetables				30%
79	Asia	Nepal	vegetables		10%	50%	30%
79	Asia	Nepal		cauliflower			47%
79	Asia	Nepal		cabbage			43%
79	Asia	Nepal		radish			11%
79	Asia	Nepal		tomato			11%
80	Asia	Vietnam		tomato			19%
80	Asia	Vietnam		chilli			17%
80	Asia	Cambodia		tomato			25%
80	Asia	Cambodia		bean			22%
80	Asia	Cambodia		cucumber			20%
80	Asia	Cambodia		chinese kale			16%
80	Asia	Laos		tomato			17%
80	Asia	Laos		bean			12%
80	Asia	Laos		cucumber			9%
80	Asia	Laos		chilli			11%
86	Asia	India	fruit & vegetables				40%
86	Asia	Indonesia	fruit & vegetables		20%	50%	35%
86	Asia	Korea	fruit & vegetables		20%	50%	35%
86	Asia	Philippines	fruit & vegetables		27%	42%	35%
86	Asia	Sri Lanka	fruit & vegetables		16%	41%	29%
86	Asia	Thailand	fruit & vegetables		17%	35%	26%
86	Asia	Vietnam	fruit & vegetables		20%	25%	23%
91	Asia	Bangladesh	fruit & vegetables		20%	25%	23%
92	Asia	Cambodia	fruit & vegetables		35%	40%	38%
93	Asia	China	leafy vegetables				40%

Src.	Region	Country	Category	Product	PHLs		
					from	until	mean
94	Asia	Fiji	fruit & vegetables		4%	12%	8%
95	Asia	India	fruit & vegetables		20%	30%	25%
96	Asia	India		tomato			15%
97	Asia	Indonesia	fruit & vegetables		20%	50%	35%
98	Asia	Indonesia	fruit				10%
98	Asia	Indonesia	vegetables				10%
101	Asia	Nepal	fruit		20%	35%	28%
101	Asia	Nepal	vegetables		15%	30%	23%
101	Asia	Nepal	potato		15%	20%	18%
102	Asia	Nepal	fruit & vegetables		20%	30%	25%
102	Asia	Nepal		apple	20%	30%	25%
102	Asia	Nepal		citrus	15%	20%	18%
102	Asia	Nepal		tomato	10%	15%	13%
102	Asia	Nepal		cauliflower	10%	15%	13%
103	Asia	Pakistan	fruit				30%
103	Asia	Pakistan		apple			27%
103	Asia	Pakistan		apricot			45%
103	Asia	Pakistan		cherry			63%
103	Asia	Pakistan		grapes			21%
103	Asia	Pakistan		mulberry			51%
103	Asia	Pakistan		peach			30%
103	Asia	Pakistan		pear			15%
103	Asia	Pakistan		plum			34%
103	Asia	Pakistan		pomgranate			31%
103	Asia	Pakistan		walnut			7%
103	Asia	Pakistan		almond			6%
103	Asia	Pakistan		other fruits			26%
104	Asia	Philippines		banana	30%	40%	35%
104	Asia	Philippines		papaya	27%	42%	35%
105	Asia	Philippines		lettuce	20%	34%	27%
105	Asia	Philippines		celery	8%	20%	14%
105	Asia	Philippines		carrot	14%	20%	17%
105	Asia	Philippines		cabbage	14%	25%	20%
105	Asia	Philippines		cauliflower	10%	19%	15%
105	Asia	Philippines		chinese cabbage			10%
105	Asia	Philippines		potato			9%
105	Asia	Philippines		bean			9%
105	Asia	Philippines		broccoli	10%	21%	16%
105	Asia	Philippines		bell pepper			6%
105	Asia	Philippines		sweet pea			2%
107	Asia	Sri Lanka	fruits		30%	40%	35%
107	Asia	Sri Lanka	vegetables		16%	41%	29%
107	Asia	Sri Lanka		eggplant			35%
107	Asia	Sri Lanka		beet			27%
107	Asia	Sri Lanka		cabbage			41%
107	Asia	Sri Lanka		carrot			28%
107	Asia	Sri Lanka		leek			41%
107	Asia	Sri Lanka		tomato			35%
107	Asia	Sri Lanka		bean			25%
107	Asia	Sri Lanka		bitter gourd			22%
107	Asia	Sri Lanka		okra			16%
107	Asia	Sri Lanka		banana			30%
107	Asia	Sri Lanka		pineapple			31%
107	Asia	Sri Lanka		papaya			36%
108	Asia	Sri Lanka	vegetables		16%	40%	28%
108	Asia	Sri Lanka	fruits		30%	40%	35%
109	Asia	Thailand	fruits				25%

Table 1 continued

Src.	Region	Country	Category	Product	PHLs		
					from	until	mean
109	Asia	Thailand		cucumber			14%
109	Asia	Thailand		tomato			20%
109	Asia	Thailand		cabbage			16%
109	Asia	Thailand		lettuce			12%
109	Asia	Thailand		rape			6%
109	Asia	Thailand		chinese cabbage			14%
109	Asia	Thailand		parsley			24%
109	Asia	Thailand		spring onion			19%
111	Asia	Vietnam	fruit & vegetables				25%
111	Asia	Vietnam		litchi	25%	30%	28%
111	Asia	Vietnam		longan	25%	30%	28%
112	Asia	Vietnam	fruits		20%	25%	23%
112	Asia	Vietnam	vegetables				30%
115	Asia	India	fruit & vegetables				30%
115	Asia	China	vegetables				20%
115	Asia	Thailand	fruit & vegetables				38%
116	Asia	India		mango			6%
116	Asia	India		tomato			13%
116	Asia	India		banana			5%
116	Asia	India		onion			5%
116	Asia	India		okra			10%
116	Asia	India		lime			10%
116	Asia	India		potato			5%
116	Asia	India		guava			13%
116	Asia	India		papaya			13%
116	Asia	India		chiku			13%
7	Middle East	Iran	fruit	orange			30%
11	Middle East	Jordan		tomato			19%
11	Middle East	Jordan		squash			22%
11	Middle East	Jordan		sweet pepper			23%
11	Middle East	Jordan		eggplant			18%
11	Middle East	Jordan		grapes	31%	38%	35%
42	Middle East	Iran	agriculture		23%	46%	34%
45	Middle East	Iran		grapes			13%
45	Middle East	Jordan		egg plant			19%
45	Middle East	Jordan		tomato			18%
45	Middle East	Oman	fruit & vegetables		3%	19%	11%
45	Middle East	Saudi Arabia		cucumber			21%
45	Middle East	Saudi Arabia		dates			15%
45	Middle East	Saudi Arabia		figs			20%
45	Middle East	Saudi Arabia		grapes	16%	23%	20%
45	Middle East	Saudi Arabia		tomato			17%
86	Middle East	Iran	fruit & vegetables				>35%
99	Middle East	Iran		strawberries	35%	40%	38%
99	Middle East	Iran		saffron			
6	South America	Brazil	fruit	stone fruit			5%
27	South America	Brazil	fruit & vegetables				17%
28	Latin Amercia & Carribean			pineapple			17%
28	Latin Amercia & Carribean			mango			21%
28	Latin Amercia & Carribean			papaya			58%
43	South America	Venezuella	brocolli				49%
43	South America	Venezuella	celery				48%
43	South America	Venezuella	lettuce				35%
61	Latin America			tomato			30%
61	Latin America			bell pepper			30%
10	low income countries		fruit & vegetables		15%	50%	33%
10	low income countries			potato			8%

Src.	Region	Country	Category	Product	PHLs		
					from	until	mean
10	low income countries			sweet potato	35%	65%	50%
10	low income countries			yam			5%
10	low income countries			cassave			
10	low income countries			taro	12%	15%	14%
10	low income countries			plantain			33%
29	developing countries		food		10%	50%	30%
64	developing countries		fruit & vegetables				>50%
71	developing countries		fruits		15%	50%	33%

Appendix 5 - Causes of postharvest food losses

Overview of main categories and subcategories

Cat.	*Subcategory*	*Explanation*	*Ref.'s*	*Total*
1. Cold chain / transport climate control	a. Unsuitable / unfit transportation vehicles	Transport modes (trucks) are not designed or equipped for the (long-distance) transport of fresh produce	36	
	b. Absence of cold chain infrastructure	An uninterrupted chain of storages, conditioned rooms for processing, refrigerated transport and product display is generally absent	15	
	c. Poor of limited cold chain infrastructure	Elements of cold chain are partly in place but do not create an uninterrupted cold chain	7	
	d. Pre-cooling	absence of pre-cooling affecting quality of produce, or when pre-cooling is available it is used poorly	7	
	e. Temperature management	Insufficient knowledge of proper T-settings causing damages to produce	4	
	f. High costs of maintaining cold chain	Installing and maintaining a cold chain is expensive, and limitedly rewarded through premium price	2	
	g. No refrigerated display of produce in retail	Traditional retail markets (street) cause a break in the cold chain	3	
	h. Poor maintenance and inefficiency	Failure of the cold chain due to lack of proper maintenance and inefficiency of utilisation of cold storage and refrigerated transport facilities	1	
	i. Absence of cold chain on farmer communal and household level	Absence of cold chain facilities in rural communities for cooled handling, storage and transport of fresh produce	1	**76**
2. Storage facilities	a. Availability of cold storage facilities	No or limited or insufficient availability of cold storage rooms	32	
	b. Large variation in storage performance / non-adaptive use	Storage performance varies, due to lack of knowledge on operations and settings, relying on fixed rather than adaptive storage climate settings	28	
	c. Occurrence of diseases and product damages / bacterial damage	Poor monitoring of product quality before entering the storage that spoils other produce, and/or faulty climate settings that affect quality	6	
	d. Inefficient use of storage	Existing storage facilities are poor / outdated, or are not used to their full potential / high input – low output	2	
	e. Occurrence of weight loss	Produce lose weight as a result of poor storage and/or too long storage time	1	**69**

Cat.	*Subcategory*	*Explanation*	*Ref.'s*	*Total*
3. Postharvest product handling	a. Rough handling of produce	Rough handling of produce in the postharvest chain will cause damages to and quality loss	26	
	b. Poor handling of produce	Absence of grading and sorting in the postharvest chain, or poor application of these will lead to increase of losses	25	
	c. Inefficient, outdated and low level of technology	Technology level in postharvest handling is low, and available equipment is outdated, creating inefficiencies	8	
	d. Absence of product standardisation	Absence of standards for grading and sorting by quality leads to a high variation in size and quality. This complicates standardised grading and sorting procedures	3	
	e. Absence of produce sorting	Without sorting damaged product will stay in batch, susceptible to rot, moulds, etc. and making good produce vulnerable to deterioration	3	
	f. Harvest timing	Poor timing of harvesting will affect entrance quality of produce in the postharvest chain	1	
	g. Export driven	Use of postharvest handling technology is often linked to export of produce only	1	
	h. Lack of postharvest product treatment	Produce is not treated to prevent postharvest deterioration due to biological / physiological processes	1	
	i. Poor temperature control during harvest	This will lead to (unnecessary heating of produ-ce and more time to cool down the produce before storage. All in all this will affect product quality negatively	1	**69**
4. Packaging	a. Inadequate packaging in storage and transport	Use of packaging that is not suited for (long term) storage or for (long distance) transportation	22	
	d. Low technology packaging	Use of (traditional) packaging with poor mate-rial and no design, causing damages to product during handling, storage and transportation	15	
	e. Inappropriate use of packaging	Overfilling of product packages and wrong stacking of packages causing bruises, dents, punctures in produce; mixing of products	8	
	f. Shortage of material	Lack of packaging material in local markets	4	**49**

Cat.	*Subcategory*	*Explanation*	*Ref.'s*	*Total*
5. Infrastructure & connectivity	a. Poor road quality	Quality of roads that exist is bad, particularly in rainy seasons	17	
	b. Little investment in infrastructure	Public expenditures on infrastructure (roads, rail, energy) is limited, particularly in remote areas	13	
	c. Poor infrastructure	Underdevelopment and unreliability of physical distribution and energy network creates obstructions in the cold chain	4	
	d. Poor logistical planning	as a result of poor design and/or stage-wise construction with inadequate planning for future expansion	3	
	e. Long transport lead time	Transportation of produce throughout the chain to the market takes a long time because of bad connectivity and long distances to markets	2	
	a. Constraints domestic and export marketing	Poor connectivity imposes constraints on possibilities to produce for export and local (remote) markets	1	
	b. Transport facilities	Low availability of transport means	1	
	c. High costs	High transportation costs block further distribution of produce in (remote) markets	1	**42**
6. Market information / product pricing	a. General lack of market information	lack of information on prevailing demand, supply and price of fruits and vegetables and vegetables in various markets	18	
	b. Peak season – low pricing	Overflowing of (local) markets of product abundance during peak season causes surpluses in the market and prices to plummet, creating losses of unsold produce	8	
	c. No price premium on quality	The (local) market does not pay rewards on quality	5	
	d. Insight in consumer demand	Producers lack information on consumer demand	1	
	e. Low product prices at time of harvesting	Low market prices create no incentive to producers, resulting of crop unharvested in the field	1	
	f. Nontransparency of pricing system	High dependence on middlemen by producers creates limited insight in pricing system on a local/regional/national level	1	
	g. Absence of (well-functioning) marketing facilities	Inefficient marketing system leads to a wide variation in prices	1	**35**

Cat.	*Subcategory*	*Explanation*	*Ref.'s*	*Total*
7. Education / R&D	a. Limited or no education / skills of personnel working in postharvest chain	Workers are untrained or unskilled in operating PH technology and/or unaware of PH protocols	20	
	b. Low level of education of farmers	Low education level leading to inability to adapt new technologies and innovations	5	
	c. R&D capacity	Poor or no facilities for postharvest R&D	2	
	d. Structural absence of sharing information to supply chain partners	Poor transfer of information, back and forth, between partners in the supply chain	2	
	e. Insufficient knowledge on PH handling with producers and market intermediaries	Absence of supply chain management geared towards optimal product quality	1	
	f. Knowledge gap in postharvest technology	In particular knowledge in packaging and packaging materials is lagging	1	
	g. Lack of entrepreneurial capacities	Lack of data on investment decision variables and inability to entrepreneurial approach creates risk-aversive behaviour of producers, sustaining the status-quo	1	
	h. Weak infrastructure for science & education	Overall poorly developed infrastructure for higher education	1	**33**
8. Processing capacity	a. Lack of or inadequate processing facilities	No outlet for second and third grade product quality due to absence of processing industry.	14	
	b. Absence of standards on quality and food safety	Causing (risk of) cross contamination in processing, causing loss of quality	6	
	c. Low technical efficiency	Generating high wastes and food losses	6	
	d. Need for technical innovations in product processing	Available processing techniques are traditional (e.g. drying, heating/preserving, cutting, filling, etc.) and require modernisation	4	
	e. Lack of auxiliary industries	Lack of spare parts and consumables for processing industry	2	**32**
9. Standards in quality / quality control	a. Produce does not meet quality requirements	Not meeting quality standards particularly relevant in produce for export market, leading to product rejections in country of origin or upon destination in export market	10	
	b. Inconsistency in standards	Lack of clear standards, or enforcement of these, gives ample room for subjective interpretation and evaluation	5	
	c. Heterogeneous quality supplied to market	Small and medium sized farmers supply a wide variety of quality, creating a mix of good and damaged product	5	
	d. Absence of services for quality monitoring	Absence of services for quality inspection, testing and certification of produce	3	

	e. Quality ignored	Quality is ignored by producers, and by collectors / wholesalers, giving little incentive to perform on quality, leading to losses in the supply chain	2	**25**

10. Investment capacity / credit access	a. Absence of capital for investment	Lack of access to capital, collateral (property rights) and high interest rates obstruct investment in postharvest technology	12	
	b. Individual low product volumes impede private investment in storage facilities	Low investment levels in rural areas due to small-scale production, making it difficult to achieve improvements in efficiency and economies of scale	4	
	c. No incentive to invest in storage / PH technology	Low product prices and small revenues create no incentive for small scale farmers to invest in technology to improve production and storage	3	
	d. High risk level creating insecurity	Better-functioning of markets and the availability of capital would increase the efficiency of the food chain	2	
	e. Limited cash flow of producer	lack of cash with producer creates no opportunity to store and sell produce outside the main harvest season, creating product gluts	2	
	f. Lack of information on costs and benefits	Lack of information creates reluctance to invest in PH technology	2	**25**

11. Chain length	a. Large number of middlemen leading to long supply chains	logistic chains and marketing chains of fresh fruits and vegetables are very long and complicated leading to a high degree of distribution risks and loss / lack of information	8	
	b. Dominant role of middlemen	Creating dependence of producers, low pricing and cutting of producers from the supply chain	2	
	c. Small price margins due to long chain	Long chain adds to costs and losses, and decreases margins	3	**13**

12. Available services	a. Information and extension services on best-practice technologies	Practical information on postharvest improvements does not reach the producers	4	
	b. Lack of science-based extension services	Link through extension services between science-based practical research and the sector is absent or insufficient	4	
	c. Little focus on postharvest in extension programmes	National extension service programmes have a tendency on focussing on production issues and not on the postharvest chain	2	
	d. Inadequate / ineffective extension service system	Low impact of extension services on addressing postharvest loss issues	2	
	e. Access to (affordable) sources of information services	Lack of information sources that may help to identify the main reasons and agents responsible for food losses	1	**13**

Cat.	*Subcategory*	*Explanation*	*Ref.'s*	*Total*
13. Crop protection	a. Absence of pre-harvest disease management	Negligence of pre-harvest control of pests and diseases affects postharvest product quality and increase of losses in the postharvest chain	5	
	b. Absence of post-harvest disease management	Negligence of post-harvest control of pests and diseases results in loss in quantity and quality of produce in the postharvest chain	4	
	c. Moulds, bacteria, pests and weather	Losses incurred as a result of vulnerability of fresh product tissue, damages inflicted to produce, absence of effective protection from insects, birds, rodents, weather, etc.	3	**12**
14. Structure, type of organisation	a. Little organisation of smallholder farms	High level of fragmentation and low levels of co-operation in supply chain marketing obstruct economies of scale and efficiency (slow introduction of new technologies)	9	
	b. Vast representation of small-scale farmers in the supply of fresh produce	Small-scale is often associated with limited financial resources, poor access to infrastructure and lack marketing channels for distribution	1	
	c. Government monopolies	State monopolies in input supply and (export) marketing create little incentive for improvements by private sector farming, sustaining inefficiencies	1	**11**

Appendix 6 - Report of the workshop 24 January 2013

Network of Excellence Postharvest Food Losses: Challenge or Choice

Report of the workshop held on 24 January 2013
Utrecht, the Netherlands

Content

1. Introduction

On 24 January 2013 a workshop was organised by the Ministry of Economic Affairs in collaboration with Wageningen UR Food & Biobased Research (FBR). The workshop was part of the project 'Network of Excellence Agrologistics for the Reduction of Postharvest Losses', a project that was contracted by the Ministry of Economic Affairs to FBR. The title of the workshop '*Network of Excellence Postharvest Food Losses: Challenge or Choice'* reflected both the content of the workshop and the challenge for the discussion with the participants of the workshop. The workshop consisted of two parts:

1. Plenary presentation by FBR on the project background, objectives and results
2. Break-out session in working groups

A copy of the plenary presentation is enclosed as attachment to this report, giving input to the discussion in the working groups. A total of 4 working groups were formed, each presided by a moderator. The composition of the working groups reflected the mix of the participating stakeholders, i.e. business, knowledge institutes, ngo's, services (financial, consultancy) and public sector, in order to achieve a balanced discussion within each group.

The discussions in the break-out session concentrated on the following questions:

- What should be the added value of the network to make it interesting for you?
- What will make the network unique?
- Define 'excellence': how to give shape to the network's 'excellence'?
- What will be the main tasks of the network and how will it work?
- What is essential for success and what are the urgent first steps?

This report is the summary transcript of the discussions that have taken place within the working groups. The content of the minutes from these discussions have been structured around the following 4 components that apply to the networks:

i. added value / (unique) selling point
ii. profile, positioning & organisation
iii. focus & tasks
iv. tools, impact & success factors

Within these components the relevant aspects are listed that have been discerned by the various working groups and have been exemplified as such. This following overview is to be interpreted as views, opinions and statements that were expressed by the individual participants during the sessions and in the following plenary discussion. These views will be used as building blocks in the further design and development of the Network of Excellence.

2. Outcome from the workgroup discussions

2.1 Added value / (unique) selling point of the network

Matching demand & supply	▪ The network is a one-stop desk for (foreign) business parties, intermediaries, extension services, etc. etc. for addressing postharvest issues / questions ▪ Through the network local parties will be matched with network partners on specific postharvest issues
Multidisciplinary approach	▪ The network will apply a multidisciplinary (system solution) value chain approach in providing postharvest solutions (software-hardware-orgware). ▪ The network will establish co-operations between different stakeholders (business, science, political level). In this co-operation intelligence, expertise and networks from these stakeholders will be combined. ▪ The postharvest has the flexibility to identify / implement postharvest tailored solutions (not 1size4all) ▪ The approach will involve also closed supply chain concepts to make chain sustainability an inclusive part of the postharvest solution (reuse, recycle) ▪ It should be considered to include processing of fruits and vegetables more prominently
International positioning	▪ The network provides a clear focus in positioning Dutch postharvest knowhow and technology in developing markets ▪ The network will identify local parties with specific postharvest issues, and will so create new leads for the network members ▪ As such, the network will be a generator of projects, and a generator of information that is focussed on business and development in the postharvest chain ▪ In this the network will function also as a platform for organising training, education, and the transfer of postharvest skills
Impact	▪ The network is effective as an operational network that brings about coalitions of trustworthy parties, addressing specific postharvest questions. It is able to set-up clusters of parties that know each other and are complementary to each other.

- The network will develop quick actions with a clear direction
- The network establishes the (pre-)feasibility of specific postharvest questions, incl. the (potential) availability of resources or funds for financing
- Impact by quick back-coupling of information
- Impact through dissemination of knowledge: information, training, transfer of skills

Finance

- The network has access to or has available financial means for organising network activities in the pre-competitive phase. This includes also the availability of resources to finance the (pre-) feasibility activities, should this be required.
- The network has access to financial networks / service providers that enable investments in POSTHARVEST solutions
- The network's start-up phase is supported by financing (seed money) from the Dutch government

2.2 Network profile, positioning & organisation

Network profile / cohesion

- The network's product is knowledge on solutions for reducing postharvest losses.
- The 'excellence' (or excellence+) label should be positioned as a quality label and a reference for the professionalism of the network members / - partners and for the quality of its services and results
- The network emanates 'excellence' by selecting professionals that can be characterised as frontrunners in their respective field of expertise (creative and international entrepreneurs)
- The network must have its basis in the Netherlands, but should open to foreign parties with postharvest excellence
- The network will disclose to its members an internal network, connecting members within the network, and will facilitate the building of confidence between network members
- The network profile includes the availability of postharvest expertise and the accessibility to parties that can disclose this expertise.
- This includes also training, education, transfer of postharvest skills

Organisation

- The network will have a dedicated network moderator or process controller
- The organisation of the network should be business-driven: companies are the primary driving force for network action

2.3 Network focus & tasks

Matching demand & supply

- Network actions are initiated upon specific demand, enabling the supply of expertise on postharvest issue. postharvest solutions must be geared to a specific demand from one or more parties.
- Through the network local parties are matched with network partners on specific postharvest issues, at the right partners, at the right phase and time in the process
- A need exists for insight in Dutch postharvest solutions and the parties that can provide in these solutions. A task of the network is therefore to present the network as an overview of companies, institutes etc. in the postharvest chain with their expertise

Focus & result oriented

- Step-by-step approach: select country, product and chain – and create a process of self-learning and evolving
- Focus on decrease of food losses and on the local value chain:
  $\text{WIN}_{\text{Business}} +/+ \text{WIN}_{\text{Sustainability}} = \text{WINWIN}$
- Strive after sustainability of the network over longer period of time, do not focus on short term (commercial) objectives
- Focus on network actions with short term goals

Network's main tasks

- The primary task of the network moderator is co-ordination of activities; network members will deliver active contribution in project incubation and implementation co-ordination and organisation of activities / linking pin
- Other tasks are communication (internal, external), promotion, creating network exposure (national & international)
- Matching demand and supply / partnermatch
- Collection of information and data for (pre-) feasibility assessment / demand articulation
- Develop / provide network for local organisation and project

infrastructure
- Monitoring of impact, progress in relation to the network's focus: reducing postharvest food losses
- Establish co-operation on business-, science- and political level
- Enable the transfer of postharvest knowledge and skills

2.4 Tools & success factors

Tools / instruments
- Use new multimedia and communication-technology tools
- Set-up network postharvest database with relevant parties (business, science, NGO, a.s.o.) (downside: each database requires maintenance to remain up-to-date)
- Create a one-stop desk for addressing postharvest issues / questions
- facilitate an open source platform (LinkedIn)
- focus on publications, communication of results (exposure)

Success factors
- Ability to act quickly – set up concrete pilot projects
- Create synergy with other networks and position the Network of Excellence Postharvest Food Losses in relation to these networks (additionality) (e.g. Agri-Profocus, Network Agrologistiek, IDH, etc.)
- Ability to create benefits for local and foreign companies
- Rapid formation of coalitions
- Not only focus on short term (commercial objective) but also on long term objective of the network
- Sharing knowledge
- Development of knowledge

3. Conclusions

Based on the previous some conclusions have been drawn:

Demand driven:	Consensus exists about the network approach, that it should be driven by a clear and concrete demand on postharvest issues in the developing countries. The network will perform an intermediary role as matchmaker between network members and network clients.
Network product:	The network's product is knowledge on reducing postharvest losses in the FSC for fruit and vegetables in developing countries.
Excellence:	Excellence is to be profiled as a quality label in the international positioning of the network. Potential members should be invited to the network on the basis of their performance and profile as frontrunners in their field of expertise.
Network members:	The network will have its basis in the Netherlands, but should be open to parties from other countries as well. Guiding principle should be that network membership is based on excellence and complementarity rather than nationality.
Network moderator / controller:	For daily network operations it is necessary to have a dedicated moderator, responsible for co-ordinating activities, communication, network exposure and representation, etc.. The network and its moderator/controller should form a linking pin within the network and between the network and its (potential) clients.
Cohesion / confidence:	There is a need exists to get to know each other (build confidence), learn from each other and to establish a basis for co-operation through concerted network action. Also insight in providers of postharvest solutions is appreciated (network/information database, 'yellow pages').
Pilots:	A need exists to organise one or two network pilots to initiate action on a short term basis. Some participants stressed that

	short-term action is preferred over long-term network development.
Finance 1:	The network should have access to financial resources for implementing its network activities. Provision of seed money in the start-up phase and for developing the network organisation will be needed.
Finance 2:	The network will enable access to financial networks / service providers that enable investments in postharvest solution.
Sustainability:	Cutting food losses in the FSC will strengthen the chain performance and sustainability. Additional sustainability can be gained by including processing of waste streams within closed supply chain concepts. Processing of fruits and vegetables should be considered as well.

Annex 1

Presentation by Wageningen UR Food & Biobased Research

<<to be included with PDF-version>>

Annex 2

List of Participants

Smeding	Marco Duineveld
Nature's Pride	Rogier Rook
Nature's Pride	Alex Daalman
Geerlofs Koeltechniek	John Tsoutsanis
Fresh Food Technology	Edwin Willemsen
Fresh Food Technology	Sander van Schaik
World Connectors / 1-2-1	Hans Eenhoorn
Rabobank Foundation	Pierre L. van Hedel
Triodos Facet	Nienke Stam
Agri-Profocus	Jan Willem Eggink
ICCO	Marijke de Graaf
CTA	Judith Francis
Dinalog	Liesbeth Staps
Netwerk Agrologistiek	Michael Jurriaans
Frugiventa	Peter Verbaas
WUR Centre for Development Innovation	Petra Spliethof
WUR Food & Biobased Research	Paul Bartels
Wageningen International	Jennie van der Mheen
Buck Consultants International	Erik Koekebakker
TNO	Henk van Deventer
FD&M Consultancy	Gert van Santen
WUR Food & Biobased Research	Peter van Ravensbergen
WUR Food & Biobased Research	Joost Snels
LEI Wageningen UR	Lusine Aramyan
LEI Wageningen UR	Yuca Waarts
WUR Food & Biobased Research	Frans-Peter Scheer
WUR Food & Biobased Research	Addie van der Sluis
WUR Food & Biobased Research	Bart van Gogh
Ministerie EZ	Niek van Dijk
Ministerie EZ	Lucie Wassink
Ministerie EZ	Mireille Boshuizen
WING	Henk Smits

Appendix 7 - Selection of international networks

Networks on food production system and food security

Selection of relevant international networks on food production systems and food security

Name	Network moderator	Description	Content	Network focus	Web link
ADM Institute for the Prevention of Postharvest Loss	University of Illinois	The ADM Institute for the Prevention of Postharvest Loss goals is to serve as an international information and technology hub for evaluating, creating and disseminating economically viable technologies, practices and systems that reduce postharvest loss in staple crops such as corn, wheat, and oilseeds.	postharvest losses of staple crops	research	postharvestinstitute.illinois.edu
Agri-Profocus	Vereniging Agro-Profocus (NL)	Network organisation with members from the Dutch corporate sector (Heineken , Rabobank) and knowledge institutes (Wageningen UR) , NGOs, Agentschap NL, CBI, a.o. The organisation organises activities on co-operation and exchange of information between the Dutch affiliated organisation and local parties in Africa on the subject of farmer entrepreneurship.	Farmer entrepreneur-ship	Training, dissemination	www.agri-profocus.nl
AVRDC World Vegetable Centre	AVRDC, Taiwan	AVRDC – The World Vegetable Centre, an international non-profit research and development institute, is committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of nutritious and health-promoting vegetables. Network in Asia and Africa.	On farm production and (PH) technology	innovation	http://avrdc.org/?page_id=276
BiD Network	BiD Network Foundation (NL)	BiD Network's mission is to contribute to sustainable economic growth in emerging countries through entrepreneurship. BiD network connects entrepreneurs, coaches and financiers with each other. BiD Network has partners in 16 emerging countries. These are business support centres, business incubators, universities, NGOs, angel networks, and business schools. Themes: food systems, rural energy, water and sanitation.	Business development, finance	Advisory, coaching, matchmaking	www.bidnetwork.org
BOP Innovation Centre	Stichting BoP Innovation Centre	The BoP Innovation Centre enables the development of new business models, encompassing all areas of the supply chain from sourcing and production to new products and services sold on the	Innovation, business development	Technical innovation, advice,	www.bopinc.org

Name	Network moderator	Description	Content	Network focus	Web link
		market. Developing sustainable innovations, capturing and sharing learnings and working to improve the enabling environment. BoP Inc.'s ambition is to help explore the potential of these markets and to create new business propositions through partnerships with leading companies and engagement with societal stakeholders.		facilitate, exchange	
CBI	Ministry of Foreign Affairs	Centre for the promotion of imports from developing countries. Export support programme, focus on 48 developing countries and 27 sectors. Transfer of market intelligence on specific EU markets / product groups in support of producers in those 48 selected countries.	EU market information, standards	Dissemination, training	www.cbi.eu
EU-FUSIONS	Wageningen UR	The EU-FUSIONS project will establish a tiered European multi-stakeholder Platform to generate a shared vision and strategy to prevent food loss and reduce food waste across the supply chain through social innovation. The overall aim of the project is to contribute significantly to the harmonisation of food waste monitoring, feasibility of social innovative measures for optimised food use in the food chain and the development of a Common Food Waste Policy for EU27.	Food waste monitoring, policy	Collaboration and interac-tion, research	n.a.
Food Valley	Stichting Food Valley	Food Valley stimulates innovation in the Dutch agro-food sector. It acts on its 'conscience': the needs expressed by the business community. By partnering knowledge with enterprise, food expertise in the Netherlands is put to optimal use.	food and nutrition	scientific research	www.foodvalley.nl
Global Alliance on Food Security Research	unknown	Network consisting of six leading agri-food universities and research institutions from the main food-producing countries in the world who have joined forces to find ways to increase the world food production in a sustainable manner. Within the network projects are developed that are focused on the increase of food production with fewer natural resources. Amongst others: Stimulating the use of	food security, prevention food losses and spillage	R&D	http://www.gafsr.wur.nl/UK/about_us

Name	Network moderator	Description	Content	Network focus	Web link
		fresh products and avoiding post-harvest losses and food waste.			
Greenport Holland International	Stichting Greenport Holland International	'Horticultural partnership' of Dutch horticultural agribusiness, knowledge institutes and the public sector. The network mission is to extend the business model of the Dutch horticultural cluster to international, sustainable horticultural projects.	Horticultural technology and trade	Business development, promotion	greenportholland.com
ICEFood Chili	Wageningen UR	International Centre of Excellence for Food – the expertise centre is to conduct a research, development and knowledge valorisation programme. To begin with, six Chilean knowledge institutes will be taking part, and the first projects involve eight Chilean companies. The research encompasses four different themes: Food Processing and Structuring, Consumer and Health, Food Safety and Supply Chain Sustainability. Various public-private cooperation projects will be set up for each of the four research themes.	food quality, food safety	R&D	http://www.wageningenur.nl/en/show/Official-opening-of-ChileanWageningen-expertise-centre-in-Chile.htm
INPhO	FAO	INPhO, the Information Network on Post-harvest Operations, was originally designed by FAO with the support and collaboration of GTZ and CIRAD in 1996, and is managed by the Rural Infrastructure and Agro-Industries Division (AGS) of FAO. The principal objectives of INPhO are to promote best practice in post-harvest activities for agricultural products and to assist in the expansion of agribusiness by providing easy access to technical data and information.	Postharvest technology	Dissemination of information on PH practices and technology	www.fao.org/inpho
Metropolitan Food Security	Platform MFS	Platform profiled as representing Dutch Food Security Parties, consisting of companies and institutes that have a interest in food production and supply, with a particular focus on securing food supply in metropolitan areas.	Food security	Business development, promotion	www.metropolitanfoodsecurity.nl
Network of Excellence	FAO	Network in development. Ambition is to create a postharvest network that will enable project development in Africa to reduce	Postharvest losses	Technical innovation	n.a.

Name	Network moderator	Description	Content	Network focus	Web link
Postharvest i.o.		postharvest losses. The initiative to develop such a network is a joint collaboration by FAO, AU and SDC.			
NpM	ICCO	NPM, Platform for Inclusive Finance, promotes inclusive finance as a contribution to poverty alleviation in developing countries. The platform, established in 2003, brings together developing organizations, social investors, private foundations and commercial banks from The Netherlands. Together with the Dutch Ministry of Foreign Affairs, the 15 Dutch members share a commitment to expanding access to finance in underserved regions and anticipate the changing need in the sector to grow towards a responsible industry.	Finance	Micro-finance enabling	www.inclusivefinanceplatform.nl
PhAction forum (dormant)	CGIAR	PhAction's mission is to act as a platform for more effective, and better coordinated interventions in the postharvest sector with the purpose of playing a catalytic role in the promotion of the postharve3st sector. Goal is to achieve greater impact on the food research sector through the development and delivery of sustainable post-harvest technologies in close collaboration with a range of partners in developing countries.	Postharvest	Scientific research	www.foodnet.cgiar.org/PhAction/index.htm
POSTCOSECHA / SDC	SDC Agriculture and Food Security Network	Program in Central America, carried out by SDC between 1983 and 2003. The main technology element of the program are locally produced metal silos, where grain is stored and protected. The silos are produced and disseminated via existing institutions and market mechanisms. Today, SDC is spreading post-harvest technology in Southeast Africa. SDC builds its post-harvest management effort in Africa on its experience with the POSTCOSECHA program in Central America, that was mainly focusing on metal silos. But it does also consider other storage solutions, depending on local conditions	(on-farm) storage facilities (staple crops)	technical innovation, dissemination	www.sdc-foodsecurity.ch/en/Home/Focus_areas/Post_harvest/POSTCOSECHA

Name	Network moderator	Description	Content	Network focus	Web link
		and needs encountered.			
Save Food	FAO	The initiative SAVE FOOD aims at encouraging the dialogue on food losses between industry, research, politics and civil society (focus on packaging). For this purpose, the initiative will regularly bring together stakeholders involved in the food supply chain from the food industry, retail, packaging, and logistics for conferences and projects and will support them in developing effective measures. Raising the awareness of consumers is another major goal.	prevention of food waste	dissemination	www.save-food.org
The Sustainability Consortium	Arizona State University / University of Arkansas / Wageningen UR	International network of private companies and knowledge institutes. The Sustainability Consortium drives scientific research and the development of standards and IT tools, through a collaborative process, to enhance the ability to understand and address the environmental, social, and economic implications of products.	development of standards and tools on sustainability of products (LCA)	Research & implementa-tion	www.sustainabilityconsortium.org
Top Institute Dinalog	Dutch Institute for Advanced Logistics	Dinalog has been founded in support of maintaining the leading position of the Netherlands in logistics and supply chain management by focusing on scientific knowledge development in this field.	logistics & supply chain management	scientific research	www.dinalog.nl
Top Institute Food & Nutrition	Stichting Top Institute Food & Nutrition	Public private partnerships of science, industry and government defined and developed around a specific (scientific) theme with the objective to attain or strengthen an international status of excellence and expertise. Within the TI's strategic research is conducted, such as on food and nutrition. Mission of the TI Food & Nutrition is to carry out interdisciplinary research that contributes to optimal human nutrition, food safety, sustainable food production and the increased competitive ability of the food industry.	food and nutrition, food safety, quality	Research, innovation	www.tifn.nl

Name	Network moderator	Description	Content	Network focus	Web link
UC Davis Postharvest Technology Centre	UC Davis	Science department to reduce postharvest losses and improve the quality, safety and marketability of fresh horticultural products.	Postharvest losses fresh horticultural products	Scientific research	postharvest.ucdavis.edu

