PEF Postharvest E-learning Manual

3rd Edition

Training of Postharvest Trainers and Extension Specialists: Small-scale Postharvest Handling Practices and Improved Technologies for Reducing Food Losses

Lisa Kitinoja

The Postharvest Education Foundation (PEF)

January 2021

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This is a free pdf e-learning manual of 12 self-managed assignments on postharvest extension methods. Assignments include identifying the causes and sources of postharvest losses, performing commodity systems assessments, determining local postharvest research, training and advocacy needs, assessing the local suitability of "best postharvest practices", performing cost/benefit analyses, and designing practical postharvest technology demonstrations and training programs for extension workers, private sector trainers, postharvest consultants and others who work with smallholder farmers, traders, food processors and marketers of perishable food crops. Each assignment is concluded with a self-exam in order to check the knowledge and skills you will have gained. Reading materials including postharvest manuals can be downloaded freely as needed. Annexes include online resources, networking links, postharvest training video links and on optional assignment on Postharvest Training and Services Center (PTSC) design.

Technical and methodological reviews by
the Board of Directors of The Postharvest Education Foundation (PEF).

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Table of Contents

Foreword

The PEF Global Postharvest E-learning Program was developed based on early instructional materials I designed in the 1990s for extension agents in Egypt, and modified for audiences in the Jordan, Lebanon, Morocco, India, Indonesia and many African countries during the period of 2001 through 2010. During 2011-20 the program was managed by our voluntary Board of Directors at PEF, who provide feedback and mentoring, and was funded by participant registration fees and private donations to The Postharvest Education Foundation.

This training manual will move the postharvest e-learning program into the public/open access space, so individuals or groups can participate at no cost, and on their own schedules. The agenda provided in this manual is similar to that of the 2016 PEF Global Postharvest E-Learning Program, but is provided without a fixed calendar, and with self-exams and access to a free on-line open forum for individuals to receive feedback and encouragement as they move through the assignments at their own pace. Postharvest tool kits and closing workshops are optional components and require a budget to cover the costs ($300 for a basic tool kit; approximately $1000 to $2000 per person for a closing workshop).

The entire program can be provided in workshop format to a live audience, and there are many demonstrations included in the assignments that can be used for the provision of the program for local audiences. We have uploaded all the readings and needed training materials to the cloud (via Google Drive) and we are disseminating this training manual as a free pdf document. Please reach out to our PEF e-learning graduates who may be in your own country – you can find them listed on our website at the link provided below.

If you are thinking of conducting a large-scale national or regional activity, it may be helpful to hire someone who has completed our PEF Global postharvest e-learning program to lead your postharvest training efforts. In 2021 PEF will be providing small grants for our e-learning graduates in order to support cooperative or collaborative local programs.

www.postharvest.org

http://www.postharvest.org/alumni_list.aspx

http://postharvest.org/postharvest_elearning_program1.aspx

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Chapter 1
Introduction to the PEF Training of Postharvest Trainers
E-learning Program and the Manual

This training manual is based upon more than 15 years of electronic instruction on topics of small-scale postharvest handling practices and the extension of improved technologies that were originally developed for use in a variety of international development projects. Typically, the extension method known as "e-learning" was used because the projects that I worked on as an international postharvest consultant provided little or no funding for in depth training and local capacity building. The available funds often did not allow me to provide face-to-face training workshops, short courses or study tours, and even international travel as an instructor was limited to one or two brief visits during an entire project. Instead, I developed practical assignments that allowed trainees to learn via a combination of reading, fieldwork and hands-on activities.

Becoming a "postharvest specialist" requires much more time and effort than attending a few days of workshop or a single short course. There are many people who do not have the financial resources to enroll in a graduate program, or even to travel internationally to attend the high quality and well-known short courses and workshop programs offered annually by the University of California, Davis (USA) or Wageningen University (The Netherlands). Becoming a postharvest expert requires dedicated fieldwork over a long period of time to understand the many factors that can be involved in causing postharvest losses. In order to reach the many young people who have been unable to participate in traditional postharvest educational programs, I developed a series of assignments that could be done by someone in their home country, and provided feedback via email, web-based chat, or most recently via discussion forums on LinkedIn.com and via live interactions using skype. During 2011-16, a series of ten assignments was provided as a mentor guided learning experience by PEF as the "Global Postharvest E-learning Program", in which each participant enrolled in January, and then moved at their own pace. This allowed even those who are working fulltime or undertaking graduate studies to find the time to participate fully and complete the program by the end of December.

The training program was originally developed with young horticultural professionals in mind, so many of the readings and examples focus on improved postharvest handling of fruits or

vegetable crops. Over the past five years the e-learning program has been expanded by PEF to include researchers, extension workers, NGO staff and graduate students who are studying and working with other crops such as grains, legumes, pulses, root and tuber crops, coffee, tree nuts, herbs and spices.

If you are interested in the background story of PEF, an interview was conducted in 2014 on the creation of The Postharvest Education Foundation and the Global Postharvest E-learning Program. LK interview on **Green is Good** radio show --   https://youtu.be/Ba-zIs3Y9FQ

This manual provides similar, mentor guided reading assignments, simple fieldwork and written reports in a series of 12 assignments, each with complete instructions for the e-learner, and each building toward the next. Full guidance is provided in the assignments-- there are instructions, readings and outlines for required reports, and a self-exam for checking your knowledge. All of the assigned reading materials are available online as free-to-download resources, and the current link to PEF's Google Drive folder of Training of Trainer (ToT) training materials is provided in the manual.

Six of the assignments require submission of a short, written report, each of which can be self-reviewed by the e-learner. An outline for each report, and a list of questions is provided for each assignment to allow the e-learner to review their learning process and their own results. If desired, a lead instructor can use the ToT manual to implement a local program, and this lead instructor can follow the guidelines provided in Annex F to review the written reports and send positive feedback and/or follow-up questions to each individual e-learner.

The PEF Global e-learning program is typically offered over a long period of time, ideally 8 to 14 months. Programs taking longer or shorter periods of time have been implemented over the years, depending upon the type of project and number of e-learners in the group. One year has been found to be the ideal amount of time for participants to absorb the enormous amount of information on postharvest technology and extension education methods provided during the program, to interact with one another across many time zones via online forums, and to develop confidence in their new knowledge and skills.

If local resources permit, at the end of an e-learning program that is guided by a lead instructor, the training should conclude with a live in-person workshop, where those participants who have completed all their written reports can gather to meet one another, share experiences, meet the instructor and receive a Certificate of Completion and their own Postharvest Tool Kit (described in Chapter 11). The cost for mounting this type of closing workshop varies by region, but for planning purposes, an estimate of $1000 to $2000 per person should cover the major expenses for travel, lodging, venues, and the postharvest tool kit available from Fanny Ipinge of the NGO "Postharvest Tool Kits and Services" in the Netherlands. The kit contains more than 20 items including a refractometer, digital scale, digital temperature probe, measuring tools, color charts, quality rating scales, quality assessment tools, and an assortment of postharvest training aids and supplies.

Annex E is an optional learning assignment on the topic of Postharvest Training and Services Center (PTSC) design. A PTSC is a postharvest innovation platform that can be designed to fit the training needs of local clientele. The PTSC can be adapted for different types of target groups. crops, and provide a location for housing a variety of postharvest demonstrations, offering training programs, and providing access to postharvest handling and marketing advice, tools and supplies.

LEARNING OBJECTIVES of this program

In this ToT program we will build knowledge and skills in:

- Assessing postharvest losses and quality problems for crops
- Accessing online resources on postharvest information and extension
- Identifying small-scale postharvest technologies and potential solutions which are most appropriate for local target groups
- Performing Cost / Benefit calculations for assessing economic feasibility of recommended postharvest technologies
- Designing postharvest demonstrations to show farmers, traders and marketers how to reduce losses, maintain quality and market value, increase shelf life and incomes
- Designing extension programs on postharvest technology topics
- Utilizing postharvest tools and equipment for quality evaluation
- Networking via social media and online forums with fellow "postharvest specialists"

Introduction slide from the 2016 PEF Global E-learning Program

AGENDA for Postharvest ToT Program covered in this Manual

Month	Topics	Assignment # (a lead instructor can add due dates)	Manual Chapter
1	Training Needs Assessment – (TNA) self-administered pre-test to identify the participant's own learning requirements, initial level of skills and experience	Assignment 1 Report 1	2
2	Introduction to the many available resources in the field of postharvest technology	Assignment 2 Guided internet searches	3
3	Learning to use Commodity Systems Assessment Methodology (CSAM) to identify the local causes and sources of postharvest losses and quality problems	Assignment 3 Reading assignment	4
4	Describing the current status of the commodity system for a crop of interest, and identifying priority research, extension and advocacy needs	Assignment 4 Report 2	5
5	Reviewing and assessing the suitability of "best postharvest practices" and available appropriate technologies for solving identified problems	Assignment 5 Reading assignment	6
6	Determining the costs and benefits of using improved practices and small-scale technologies (Worksheet)	Assignment 6 Report 3	7
7	Designing a postharvest demonstration for local farmers, traders, processors and marketers, including local cost/benefit information	Assignment 7 Report 4	8
8	Setting measureable objectives for a postharvest training program	Assignment 8 Reading assignment	9
9	Developing Postharvest Extension Programs Using simple postharvest tools and equipment for quality assessment and as training aids (Postharvest Tool Kit)	Assignment 9 Reading assignment	10
10	Designing a local postharvest training program for various audiences and groups	Assignment 10 Report 5	11
11	Evaluating the effectiveness of postharvest training programs – did we meet our objectives?	Assignment 11 Reading assignment	12
12	Final Exam and Training Needs Assessment – self-administered post-test with program evaluation/feedback questionnaire	Assignment 12 Report 6	Annex A
	End of program – Closing workshop and postharvest tool kits	Optional (can be provided if the lead	Annex D

Month	Topics	Assignment # (a lead instructor can add due dates)	Manual Chapter
		instructor has the resources)	
	Certificate of Completion (available as a signed PDF document)	Available upon submission of final exam results to PEF via email	Example in Annex D
Optional	Designing a Postharvest Training and Services Center for your country	Readings, sample designs, outline	Annex E

Training materials

A folder of training materials and supporting documents has been compiled for each assignment in the manual. The online library of PEF ToT postharvest training readings can be accessed for free via Google Drive. We will add new resources to this folder as they become available.

https://drive.google.com/drive/folders/0B5xzz3hIIS3qczRBNmlZbkZNbUE?usp=sharing

The Training Agenda provided above lists the topics and types of assignments. Deadlines for submission of the reports can be added by a lead instructor/mentor to fit the calendar for each new e-learning program. If an e-learner is taking the training on their own, the assignments can be managed to fit his or her own schedule. Mentoring can be accessed via LinkedIn.com at any time, and questions can be posted as the need arises.

Documented outcomes and impacts of the Postharvest E-learning program

Recent program evaluations were undertaken to follow up the PEF E-learning program outcomes via written survey, and an overall response rate of 92% was documented, representing trainees from all seven countries that participated in a Hort CRSP funded project during 2010-12.

An analysis of a pre-test/post-test self-administered Training Needs Assessment (TNA) survey (completed by 30 participants at the start and end of the ToT program) revealed that all but one person gained in knowledge and skills on a wide range of postharvest subjects and extension practices. Each of the 8 categories included a group of up to 8 individual related items. Every

category showed increases in both knowledge and skills for the ToT participants, and overall, knowledge changes showed an increase of 35%, while skills changes increased by 42%.

Self Assessed Training Needs on 57 topics
(TNA survey results, N=30)

Pre-test/Post-test increases in KNOWLEDGE
- Postharvest Information 35%
- Program development 28%
- Teamwork 17%
- Teaching/training 43%
- Basic postharvest practices 34%
- Cooling/cold storage 46%
- Marketing/GAPs 36%
- Costs/benefits 73%

OVERALL KNOWLEDGE CHANGES increase by 35%

Pre-test/Post-test increases in SKILLS
- Postharvest Information 34%
- Program development 35%
- Teamwork 19%
- Teaching/training 49%
- Basic postharvest practices 45%
- Cooling/cold storage 60%
- Marketing/GAPs 50%
- Costs/benefits 85%

OVERALL SKILLS CHANGES increase by 42%

The largest increases were measured for the categories of "costs/benefits" and "cooling/cold storage", most likely because these were the topics in which the trainees were the weakest at the start of the postharvest ToT program. The category of "teamwork" showed the least improvements, since this topic was not practiced as much during the e-learning program since the trainees were located too far from one another to be able to engage in group oriented assignments.

Of the 28 ToT respondents to the WFLO/TOPS evaluation survey done during 2014 for this evaluation, 14 were men and 14 were women, and their mean age was 37 years old. One person reported starting graduate school in a Master's program, and 2 are currently enrolled in PhD programs, all in the field of postharvest. Three of the 28 respondents are in non-agricultural jobs, where they do not work as postharvest trainers.

As a group, the 25 persons who did report providing postharvest training, listed training activities for more than 9,300 people (4,459 men, 4,164 women and 695 of unspecified sex) in

various postharvest, food processing and food safety topics during a one-year period from Oct 2013 through Oct 2014.

Postharvest topics included during their own local training programs

S. No.	Topics	Number of respondents	% of respondents
1	CSAM	16	57
2	Identifying causes and sources of losses	22	79
3	Handling practices	24	86
4	Food processing	17	61
5	Value chain development	18	64
6	Designing postharvest demonstrations	19	68
7	Cost and Benefit	17	61
8	Training program design	17	61
9	Postharvest tool kit	18	64

The most useful topics were considered to be: handling practices (86%), identifying causes and sources of losses (79%), designing postharvest demonstrations (68%), using their postharvest tool kit (64%) and value chain development (64%).

A new vegetable packinghouse in Lushoto, Tanzania was designed by three of the Hort CRSP ToT graduates, and funding for the construction and training of trainers was provided by the Ministry of Agriculture, Food Security and Cooperatives (MAFC). Nearly a year of set-up went into the project, which was launched in 2014 and recently turned over to the local governmental authorities (LGA) and LUKOVEG, a grower's cooperative, for local management. A visit to the packinghouse was included in the TOPS evaluation plan, and in February 2015, Dr. Kitinoja was able to meet with Local Governmental Authority (LGA) leaders, interview the packinghouse manager, meet with one of the two local extension agents assigned to the site (she trains the workers), and offer a half-day of postharvest training for local tomato farmers. Topics included harvest indices, gentle harvest, sort/grading, sizing, packing and cool storage. The LGA paid for all the local transport costs for 15 farmers to be able to attend the training at the packinghouse.

Training at the Lushoto packinghouse (photo provided by Esther Mwaisango)

The topics which were rated by the 28 respondents to the ToT survey as most useful for their clientele in developing countries were: identifying causes and sources of losses, postharvest handling practices, food processing, value chain development, designing postharvest demonstrations, cost/benefit analyses, training program design, and postharvest tool kit (all 8 of these topics were rated "most useful" by over 75% of respondents). The postharvest tool kit (89.3%) was considered to be the most useful topic by all the respondents and no respondent rated this topic as least useful. These topics are focused on the main postharvest problems experienced in developing countries, and by learning about and adopting improved handling practices and new low cost postharvest technologies, the ToT respondents felt that farmers and traders could avoid postharvest losses and improve their commodity's quality, shelf life, nutrition and also gain market access.

Training activities and their reach far exceeded the stated project target of 5000, with a total of 22,177 people (10,893 women and 11,284 men) trained in postharvest topics since 2012 by the 28 respondents in their jobs. During the first year after the completion of the ToT program, nearly 13,000 people were trained, and in just one year, without any funding being provided by the project, more than 9,300 people (4,164 women, 4,459 men and 695 of unspecified sex) were reached when postharvest training was provided by the 28 Hort CRSP ToT graduates in their home countries.

When trainers were asked about the reactions of the people they had trained regarding their interest in various postharvest topics, they felt that only a few topics were considered less useful or negative (marked in **(bold)**). The negative reactions or lack of interest was believed to be based upon the perceived high costs of these three technologies (cooling, cold room, canning).

Level of interest and reactions of local trainees about new postharvest technologies

S. No.	Technologies	Level interest (%)					Reactions (%)	
		5	4	3	2	1	Positive	Negative
1	Harvest	75	3.5	11		7	60.7	14.3
2	Use of shade	71	7	11		3.5	60.7	7.14
3	Packaging/containers	57	7	18	3.5	3.5	64.3	10.7
4	Cooling practices	**(25)**	14	**(25)**		7	35.7	21.4
5	ZECC	46	11	21		7	46.4	21.4
6	Cold room	14	7	3.5	3.5	**(39)**	10.7	**(35.7)**
7	Solar drying	54	7	11	3.5	3.5	60.7	7.14
8	Canning	7	3.5	21	3.5	**(29)**	14.3	**(32.1)**
9	Food safety	68	11	7			57.1	7.14
10	Drying	32					32.1	

Rating scale: 5= very high, 3=moderate, 1= low.

When asked about adoption of postharvest practices by local trainees, 79% of the respondents reported they have examples of trainees who are now using improved postharvest practices. Among those practices were improved harvesting and packaging practices, postharvest handling practices, Zero Energy Cool Chamber (ZECC), solar drying, cool room (made from a used reefer container), postharvest loss assessment, postharvest tools kit and materials.

Solar drying and improved packaging practices are considered to be the most used practices. Some farmers and traders of fresh horticultural crops started to dry and package, with improved plastic bags, their surplus produce or products which were not sold at the daily market, in order to

avoid postharvest losses. These practices provide value addition to the commodity and allow trainees to increase their incomes.

Half of respondents (50 %) said that didn't have any constraints in providing postharvest training. The other respondents reported constraints such as: financial constraints, the lack of materials needed to build some technologies, or lack of time to follow up on the trainees. Their training programs were supported or funded by:

- research institutions in agriculture through existing programs or projects
- links to donor agencies
- workshops sponsored by community groups
- classroom settings (for those working in universities and colleges)
- the creation of loan schemes

Several of the ToT participants have designed their own postharvest demonstrations in their home countries. These include shade structures, ZECCs, solar driers and more.

Photo of a Zero Energy Cool Chamber (ZECC) being constructed on a farm in Benin by Guy Kodjogbe, PEF board member

Photo of a solar dryers used for training and small-scale produce drying businesses in Tanzania

All of respondents (100%) consider themselves to be "**Postharvest Specialists**" and believe that they have gained new skills that will help them to continue their career in postharvest after their completion of the Postharvest ToT program in 2012. Respondents reported that they would like to finish their MSc and PhD studies in postharvest; to create their own companies or NGOs in the postharvest field in order to provide trainings for farmers and traders associations; to help their communities to use technologies such as the ZECC, processing methods, handling methods for fruits and vegetables and food safety methods. Many of the respondents (62%) reported that they would like to be consultants in postharvest field. During 2012 to 2014, 93% of respondents felt that they were more employable and had more job opportunities and 86% have used the postharvest tool kit in providing postharvest training and extension programs on improved handling and storage technologies.

When participants were asked about whether they would recommend the ToT program to other young horticultural professionals, all of the respondents (100%) said they would recommend the ToT program to potential postharvest specialists. This unanimous result was because the program helped them "to have a better understanding on postharvest issues", and to "gain technical knowledge and experience". Several of the ToT graduates have already recommended their fellow and/or younger colleagues as participants in PEF's Global Postharvest E-learning Programs, and quite a few people (from Kenya, Benin, Togo, Tanzania and Uganda) have already successfully completed the program. In addition, three of the Hort CRSP ToT graduates have made small donations to PEF (in cash, in-kind, as volunteer trainers or mentors) in order to support the education

of the 2013-2016 e-learning groups. (Author note: AVRDC sponsored three of their Arusha based staff for this PEF program in 2013, and enrolled two more staff from their Arusha office, one from AVRDC-Cameroon and one from AVRDC-Bangladesh in the 2015 program).

The knowledge they acquired through ToT online assignments and practical tour to the PTSC in Tanzania during their closing workshop supported them to work harder to reach their educational goals and future careers. Respondents reported that this type of training also makes agriculture more profitable and attractive to the youth, and contributes to enhanced food security and nutrition at the household level. Therefore, the ToT program is believed to be increasing employment opportunities for the younger generation and improving community livelihoods.

Several of the Hort CRSP ToT participants have been making waves in the international postharvest community. **Dr. Jane Ambuko** works with the Yieldwise Project (you can check out one of her videos at this link. https://youtu.be/Xs1MmH9yZGE). She spoke at TEDx in Nairobi, Kenya in December 2014 on postharvest technology, the UN FAO HLPE report on Food loss and waste, and the CoolBot cold storage research that she has been doing with the Hort Innovation Lab with Dr. M. S. Reid. Her TEDx Talk is available online at:

https://www.youtube.com/watch?v=z3qjxc4_fNA

Coolbot Technology - Post Harvest Storage Solutions | Jane Ambuko |

Three of the graduate e-learners, **Esther Mwaisango, Pendo Bigambo and Sadoti Makwaruzi**, developed a packinghouse project for the LUKOVEG cooperative and local governmental authority in Lushoto, Tanzania which was successfully funded, constructed and launched in 2014. It is now being used as a model for developing two additional packinghouses for the district, and has been documented in a DVD made by the Ministry of Agriculture, Food Security and Cooperatives. Esther was the 2014 winner of the Kader Award for Postharvest training, granted by The Postharvest Education Foundation in December 2014.

Pendo and Esther preparing fresh vegetables for a postharvest demonstration (photo by Amanda Crump, October 2012; image from a Hort Innovation Lab twitter post in December 2014).

EXPECTED OUTCOMES OF THIS ToT PROGRAM

The knowledge and skills gained from this practically oriented field based training will help to improve the quality of extension work and postharvest training programs for small and marginal farmers and a variety of food handlers, traders, processors and marketers.

By the conclusion of the program, by following the ToT manual, an e-learner can expect to:

1) Gain confidence in your capabilities to work with small farmers, traders, processors and marketers in order to help them to reduce food loss and waste, and to improve postharvest life of crops via the adoption of field tested, cost-effective practices such as gentle handling, improved packages, low cost cooling, improved storage or processing.

2) Improve your knowledge and skills in postharvest handling and small-scale postharvest technology assessment, modification, adaption, cost/benefit analysis, utilization, promotion and trouble shooting in order to reduce postharvest losses and quality problems (via practical research studies and/or extension work).

3) Gain access to evolving internet based postharvest resources, information and e-mentoring to support your long term professional development and improve job performance.
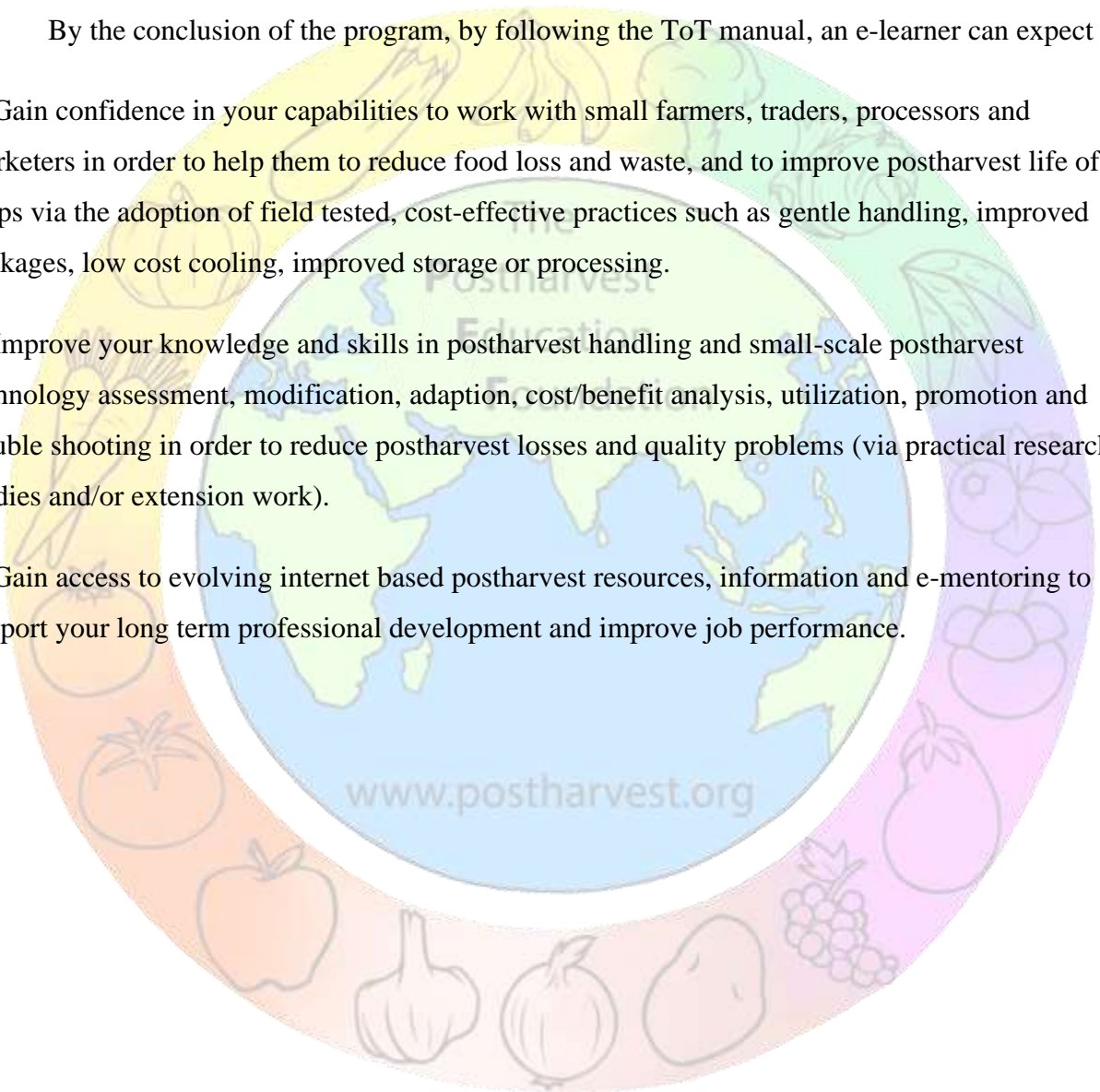
Chapter 2
Assessing the learning needs, skills and experience of the postharvest trainer/extension worker

In order to be able to know if the e-learning program has been successful in achieving the Learning Objectives and Expected Outcomes described in Chapter 1, we first need to measure the baseline level of knowledge, skills and experience of each participant.

Because the field of postharvest technology is quite complex, participants begin with a wide range of backgrounds, education and field experience, and there are many different crops, specialties and related skills, we use a comprehensive Postharvest Training Needs Assessment (TNA) survey. The TNA survey is self-administered, and therefore quite subjective, and covers 57 different topics that are grouped into 9 categories. For each individual topic, the participant rates themselves on a scale of 0 to 3 on their initial level of interest, knowledge, skills and experience.

The following is the TNA survey form used by PEF for our Global Postharvest E-learning Program. Completion of the TNA pre-test is considered **Assignment #1.** The TNA form should be downloaded from the GoogleDrive folder for Assignment 1, completed and saved so you can compare it to your final TNA form after completing the training. (The completed TNA can also be submitted to your lead instructor if there is one for your group.)

Expected Outcomes and End Results of Assignment #1:

Participants will establish a personal baseline or starting point which will be used to self-assess their end results.

Self-administered Postharvest Training Needs Assessment (TNA) Pre-test
The Postharvest Education Foundation

Full Name	
Job title	
Work Affiliation or University	
Country	
Gender	Male _____; Female _____; Others: _____
Age	
Email address	

Please rate yourself regarding your level of **Interest**, current level of **Knowledge**, level of related **Skills** and level of **Experience** in each of the categories or topics listed in the table below, on a scale where:

> **0 = none**
> **1 = low**
> **2 = moderate**
> **3 = high**

For example, you might rate yourself on:	**Interest**	**Knowledge**	**Skills**	**Experience**
Teaching general postharvest technology topics:	3	2	1	1

In this example, your interest level is **high**, and your knowledge is **moderate**, but you rated yourself **low on skills** and experience.

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
General production information:				
Identifying sources of production information				
Obtaining production information on equipment/tools				
Obtaining technical documents/scientific studies on agricultural production				
Postharvest Technology (PHT) Information:				
Identifying sources of PHT information				
Obtaining PHT information on equipment/tools				
Obtaining PHT technical documents/reports on scientific studies				
Performing postharvest loss assessments				
Participating in team Commodity Systems Assessments (survey preparation and data collection)				
Identifying causes and sources of postharvest losses				

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
Performing cost/benefit analyses to assess PHTs				
Needs assessment and program development:				
Determining client training needs/concerns in postharvest technology				
Planning postharvest extension programs for farmers				
Designing training modules and course materials in postharvest technology				
Producing extension publications:				
Brochures				
Newsletters				
Trade magazine articles				
Extension manuals				
Promoting extension programs				
Evaluating extension programs				
Teamwork:				
Writing collaborative grant proposals for research projects				
Writing collaborative grant proposals for horticultural demonstration projects				
Establishing and strengthening linkages between growers/marketers/governmental agencies				
Communicating with colleagues in other countries by email				
Training/teaching:				
Teaching general production				

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
information/principles				
Providing training in market orientation for farmers				
Designing and implementing postharvest demonstrations				
Calibrating and maintaining postharvest tools				
Designing and using group training exercises				
Developing new audio/visual training aids such as:				
Posters				
PowerPoint presentations				
Videos				
Using modern equipment for quality assessment				
Developing short courses for industry				
Designing and managing study tours				
Implementing ToT programs				
Specific Agricultural Technology Topic Areas:				
Selecting planting materials				
Methods for season extension				
Harvesting methods and tools				
Maturity indices for fruits and vegetables				
Packinghouse operations/sorting, grading, cleaning, etc for fresh produce				
Packing methods				
Packaging materials				
Postharvest pest management				
Pre-cooling methods/temperature management				

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
Relative humidity management				
Cool Storage practices				
Refrigeration systems				
Quality control and inspection				
Transportation of produce (fresh, staple crops)				
Destination marketing (domestic)				
Export marketing				
GlobalGAP/food safety practices on farm				
Food processing methods (fresh, staple crops)				
HAACP/food safety practices for processing				
Managing a packinghouse or processing facility				
Marketing strategies for small scale farmers				
Determining costs and benefits of various postharvest technologies (i.e. packing, processing, storage, shipping methods)				

For analysis purposes, each of the first 5 categories (highlighted in **bold lettering** on the survey) include from 4 to 12 topics, and the list of 22 topics under **Specific Agricultural Technology Topic Areas** is divided into 3 categories: Production/packinghouse operations (8 topics), Cooling/storage/quality control (5 topics), Transport/ food processing/marketing (8 topics), and Determining Costs/Benefits (1 topic). The sum of the self-ratings for knowledge (or interest, skills or experience) on each topic within each category are recorded as the initial or baseline level for the e-learner.

If you are using this manual for postharvest training on non-horticultural crops, you can substitute some of the horticultural technology topics (such as pre-cooling or cold storage) for any topics that are important for the specific crops that you will be focusing on. For example, if you will

be providing postharvest training on maize or rice, you may want to include "Drying practices/temperature management" instead of "Pre-cooling methods/temperature management".

The comprehensive list of topics on the TNA provides a good starting point for PEF or lead instructors to learn about the individual e-learners. The demographic data (age, gender, type of job) is sometimes used to make simple comparisons between learning outcomes by men and women, of groups from different regions of the world, or by job type. If there are additional demographics of interest to you as a lead instructor, you can add them to the top portion of the TNA form (for example: education level or urban/rural location). Note for lead instructors: At times someone will complete a TNA form and rate themselves as "3 = high" on every topic in all the categories – whenever this occurs PEF will ask the participant if they would like to participate as a resource person/mentor instead of a trainee, since they already consider themselves to be a postharvest specialist.

Over the past 10 years, most of the 170+ e-learners participating in PEF ToT programs have initially rated themselves as **high** on interest level, but **low to moderate** on knowledge, skills and experience on most of the topics. This gives them an excellent starting point for gaining new postharvest knowledge, skills and experience. "Determining Costs and Benefits of various postharvest technologies" is typically rated the lowest of all the individual topics at the outset of the program, with nearly everyone initially rating their knowledge and skills as 0 (none) or 1 (low).

SELF-EXAM for Assignment #1

Completion date of Report 1 (TNA): _____

I rated myself **high** in **interest** level for the following:

I rated myself **none or low** on **knowledge** for the following:

I rated myself **none or low** on **skills** for the following:

I already have a **high** level of **experience** in these topics:

I look forward to learning more about these topics (review the list and choose 3 or 4):

Chapter 3

Investigating available resources in the field of postharvest technology

Before you begin Assignment #2, each participant in the e-learning program should be sure to join in our free, interactive web-based support and mentoring.

Please join LinkedIn.com (it's free and easy to join), set up your profile and then link to The Postharvest Education Foundation (PEF) discussion group "Postharvest Training". You can make a direct request to join our PEF Linked In discussion group by going to this page -

http://www.linkedin.com/groups/Postharvest-Training-3770124

As a member of this group you will be able to interact with our PEF board members, graduate e-learners (PEF Alumni) and postharvest mentors from around the world. As of December 2020, our Postharvest Training discussion group on LinkedIn had more than 6400 members. There you will find active discussions, you can ask questions, post links or comments, and interact with many of the participants of current and past e-learning programs.

Assignment #2 - Guided internet searches

This assignment has 3 parts.

Part 1: Introduction to postharvest information and online resources, organizations such as PEF, PTRIC and other extension programs in postharvest horticulture and postharvest agriculture. Visit a variety of websites and read about some of the people and postharvest programs available on the web. Follow the links that are of most interest to you on each of these pages. Please utilize the internet for this assignment to make sure the pages you visit are the most up to date. (The hotlinks provided in this chapter are just examples of past web pages).

Postharvest Technology Research and Information Center (UC Davis PTRIC) now called PTC (Postharvest Technology Center)

http://postharvest.ucdavis.edu/

http://postharvest.ucdavis.edu/About_Us/Specialists_-_Faculty/ (follow links to extension specialists)

http://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/ (in English, French, Spanish, Arabic) visit a few pages for the crops that are of most interest to you

http://postharvest.ucdavis.edu/Library/Useful_Postharvest_Websites/ List of useful websites

http://postharvest.ucdavis.edu/Postharvest_Yellow_Pages/ A Resource Directory of suppliers (Wouldn't it be a good idea to have one of these directories for your country?)

http://postharvest.ucdavis.edu/Library/Food_Safety_Resources/?search=yes Food safety resources

Search the library of articles and documents (use your own key words). Download a few postharvest documents for your library.

The Postharvest Education Foundation

Website homepage: http://www.postharvest.org/

The PEF website includes postharvest resources, a page of links to postharvest innovations, information on Awards for Postharvest Training, e-learning programs, short courses, archives of PEF newsletters and much more.

FoodTank article on PEF

http://foodtank.com/news/2016/01/leading-a-global-mission-to-reduce-food-waste

PEF on Social Media

LinkedIn Group: http://www.linkedin.com/groups/Postharvest-Training-3770124

Facebook: http://www.facebook.com/PostharvestEducationFdn

Twitter: @PostharvestOrg

PostharvestOrg on YouTube https://www.youtube.com/channel/UCgPycz8ZVEwj4vWgaZyIgig

Part 2: Overview of the field of postharvest technology. Visit a wide variety of websites of organizations and read about programs in the field, visit websites with postharvest technical info (USDA, AMS, UN FAO UN inPHo, etc.). Please take some time to visit these Website links and familiarize yourself with the following organizations and agencies:

ADM Institute for Prevention of Postharvest Loss

ADMI offers free postharvest e-courses via Coursera, and focuses mainly on staple crops.

http://postharvestinstitute.illinois.edu/

inPHo – the UN FAO Postharvest Information Network

Please visit the web pages of the inPHo website and try out the search functions, compendium, training materials and library search. Includes grains, beans, legumes, oil seeds, and horticultural crops.

FAO offers e-courses on agricultural topics via their e-learning center online. http://www.fao.org/elearning/#/elc/en/home

FAO postharvest compendium (new website in 2015)

http://www.fao.org/in-action/inpho/en/

http://www.fao.org/in-action/inpho/crop-compendium/fruits-vegetables/en/

http://www.fao.org/in-action/inpho/crop-compendium/legumes/en/

http://www.fao.org/in-action/inpho/crop-compendium/roots-tubers/en/

http://www.fao.org/in-action/inpho/crop-compendium/cereals-grains/en/

http://www.fao.org/in-action/inpho/crop-compendium/oilseeds/en/

http://www.fao.org/in-action/inpho/crop-compendium/herbs-spices/en/

http://www.fao.org/in-action/inpho/crop-compendium/luxury-foods/en/

http://www.fao.org/in-action/inpho/crop-compendium/pests/en/

http://www.fao.org/in-action/inpho/resources/videos/en/

http://www.fao.org/in-action/inpho/resources/toolkit/en/

Post-harvesting Processing of Grains

http://www.fao.org/3/a-au104e.pdf

USDA Agriculture Handbook 66 (2016)

http://www.ba.ars.usda.gov/hb66/contents.html

https://www.ars.usda.gov/ARSUserFiles/oc/np/CommercialStorage/CommercialStorage.pdf

View the chapters for postharvest technologies and individual crops.

Visit some example pages for the technologies and crops of most interest to you.

Feed the Future Innovation Labs

https://feedthefuture.gov/lp/feed-future-innovation-labs

http://horticulture.ucdavis.edu/

https://ag.purdue.edu/ipia/fpl/Pages/default.aspx

https://www.k-state.edu/phl/

USDA Agricultural Marketing Service

http://www.ams.usda.gov/fv/fvpubs.htm

https://www.ams.usda.gov/grades-standards

North Carolina State University

http://www.bae.ncsu.edu/programs/extension/publicat/postharv/index.html

AVRDC – The World Vegetable Center, Tanzania   http://www.avrdc.org/

Promoting best postharvest practices. Nov 2012 http://avrdc.org/?wpfb_dl=664

Site of the model Postharvest Training and Services Center (PTSC) - Success Stories
http://horticulture.ucdavis.edu/main/media%20page/success_postharvest_tech_service_center.pdf

SAVE FOOD Initiative

The Global Initiative on Food Loss and Waste Reduction has 700 partner organizations and hosts an online forum for information sharing, plus a monthly email newsletter.

http://www.fao.org/save-food/en/

http://www.fao.org/save-food/news-and-multimedia/newsletter/en/ (in many languages)

TNAU Gadgets for Controlling Pests in Grain (via Dr. Sarma Mohan)

https://www.researchgate.net/publication/303469704_Tools_for_stored_product_insects_management_and_technology_transfer

For scientific papers - Google Scholar https://scholar.google.com

Community of Practice on Food Loss Reduction

Community of Practice on food loss reduction is a joint activity of the UN Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD) and World Food Programme (WFP) project "Mainstreaming food loss reduction initiatives for smallholders in food deficit areas" funded by the Swiss Government.

http://www.fao.org/food-loss-reduction/en/

University of California Fruit and Vegetable Preservation Resources

More than 1000 articles on food preservation authored by Dr. Diane M Barrett and many other researchers. The database is organized by topic and searchable.

http://www.fruitandvegetable.ucdavis.edu/

http://www.fruitandvegetable.ucdavis.edu/Fruit_-_Vegetable_Rsearch_Library/

Part 3: Use one of the available **search engines** to search the internet for additional websites that provide introductory information on postharvest technology for fruits and vegetables, roots and tubers or staple food crops.

Key words: postharvest, agro-industry, value chain, food supply chain, post-production, food loss, linking farmers to markets

**Expected Outcomes and End Results of Assignment #2**:

Participants will familiarize themselves with the postharvest information, training resources and programs offered by organizations such as UC Davis, USDA, UNFAO, inPHo, PEF and a variety of other online sources.

Participants will begin to link with international postharvest practitioners, build their network and interact with the postharvest professional community.

Assignment #2 Output and SELF-EXAM

Make a list of three of the websites that you have found to be most useful, then share them by posting the links and a short description of each in our PEF LinkedIn discussion group: http://www.linkedin.com/groups/Postharvest-Training-3770124

1.

2.

3.
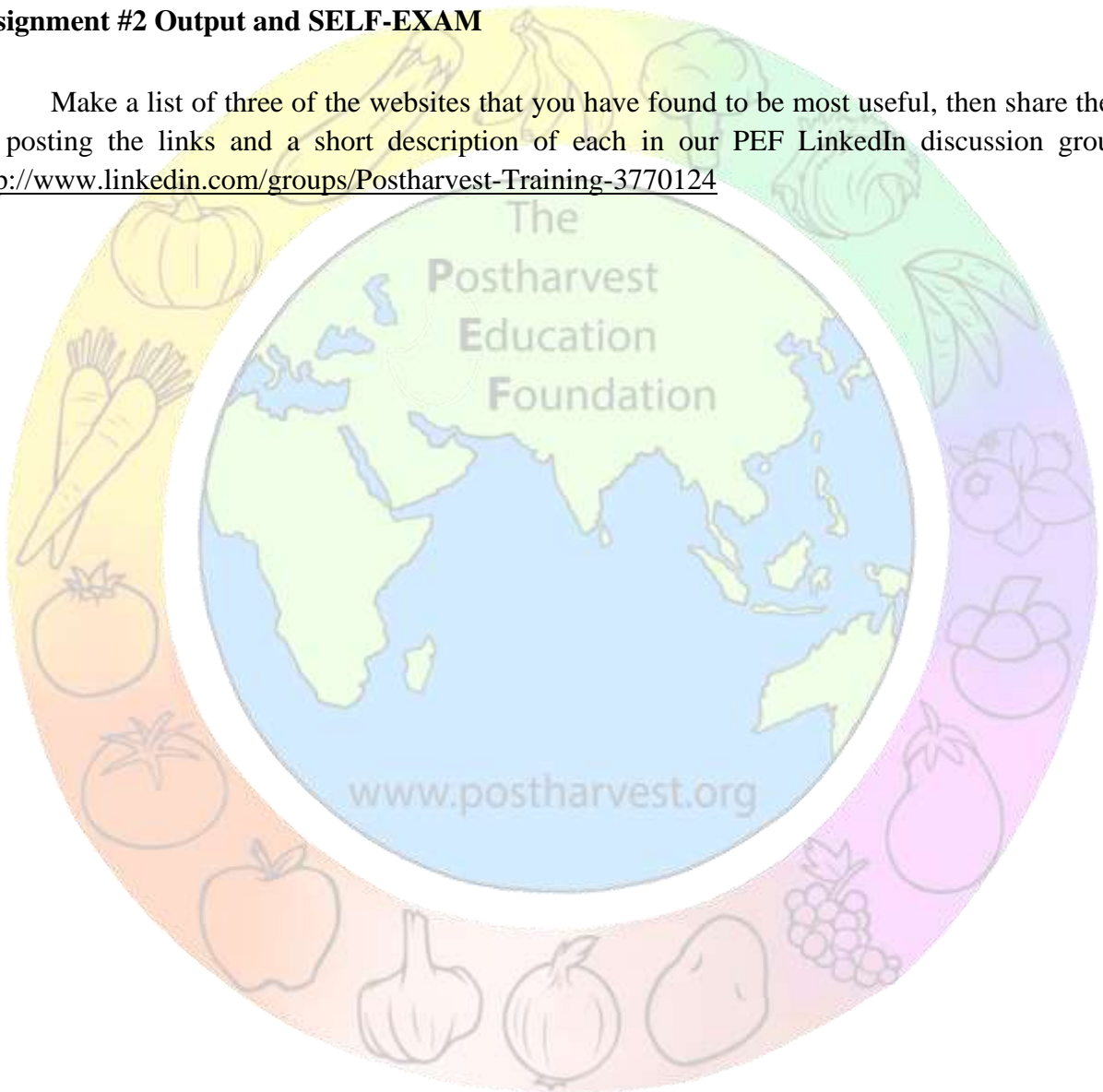
Chapter 4

Performing a Commodity Systems Assessment

The purpose of a Commodity Systems Assessment (CSA) is to identify the causes and sources of postharvest losses and quality problems for a specific crop in a specific location (a country, state or region).

This postharvest loss assessment method sets the stage for productive postharvest extension work by assessing the technical, socioeconomic, cultural, and institutional factors related to handling a given commodity in a specific locale. The end products of CSA encompass both traditional food loss assessment and cost-benefit analysis and lead to more productive extension program and project development.

The commodity system is made up of 26 components that together account for all the steps associated with the production, postharvest handling, and marketing of any given commodity. The method was developed over the course of many years and was tested extensively in the Caribbean before being introduced worldwide to field personnel via an excellent training manual on the Methodology of CSA (LaGra 1990) known as CSAM. The manual includes sample data collection instruments and detailed explanations of each of the components. The CSAM manual was recently updated and published by IICA (LaGra, Kitinoja and Alpizar, 2016). Ideally, interdisciplinary teams of people work together while investigating a commodity system--for example, a horticultural production researcher might be teamed up with a marketing specialist and an extension agent. The CSAM can help build links between agencies and individuals, close information gaps, and help people solve problems while focusing on cost effective postharvest technology.

Sample CSAM Questions. The team begins by considering a series of questions in relation to any commodity of interest, and then adds any other information that is pertinent to the situation. A list of sample questions will be provided in Chapter 5 as part of Assignment #4). Some of the questions can be answered directly by extension personnel or others who are knowledgeable about the commodity, or information can be found in available literature. Other questions may require the data collection team to observe actual postharvest handling practices and ask questions of those people who harvest, handle, and market the product. Information on the costs and expected benefits

of various postharvest technologies can be collected directly in the field or estimated from applied or adaptive research studies.

Expected outcomes. CSAM can assist a postharvest loss assessment team to determine the sources of postharvest losses (when, where and who within the marketing chain is responsible); the causes of those losses (what handling or marketing practices are responsible); and the economic value of the losses compared to the costs of current and proposed postharvest practices. Once this kind of information has been collected, extension educators can target the responsible handlers with appropriate information on cost-effective, improved postharvest technical practices. In the occasional situation where there is no existing appropriate technical solution for the handling or marketing problem uncovered using CSAM, the problem can be passed on to horticultural researchers in the universities or regional agricultural research centers. Research needs identified in a CSAM study are often used as the basis for graduate student research projects. The more information provided regarding the commodity system as a result of this CSAM, the better chance the researchers will have to identify solutions that are appropriate to the specific socioeconomic and cultural setting where the postharvest losses occur.

Assignment #3

Reading assignment on Commodity Systems Assessment Methods (CSAM) and Value Chains.

Part 1: Review the manual and data collection instruments for CSAM and Value Chains that can be found in the folder of training materials for this chapter. Our focus will be in CSAM, but you also should be aware of the value chain approach, since many projects have this focus. CSAM expands the general value chain approach to cover many of the activities and handling steps found only in food value chains.

The Inter-American Institute for Cooperation on Agriculture (IICA) in Costa Rica has published an updated version of the CSAM manual with Jerry LaGra and PEF. The link to download **Commodity Systems Assessment Methodology for Value Chain Problem and Project Identification: A first step in food loss reduction**. San Jose, Costa Rica: IICA. 246 pp.:

http://repiica.iica.int/docs/B4232i/B4232i.pdf

The original document is: La Gra, J. 1990. A Commodity System Assessment Methodology for Problem and Project Identification. Moscow, Idaho: Postharvest Institute for Perishables.
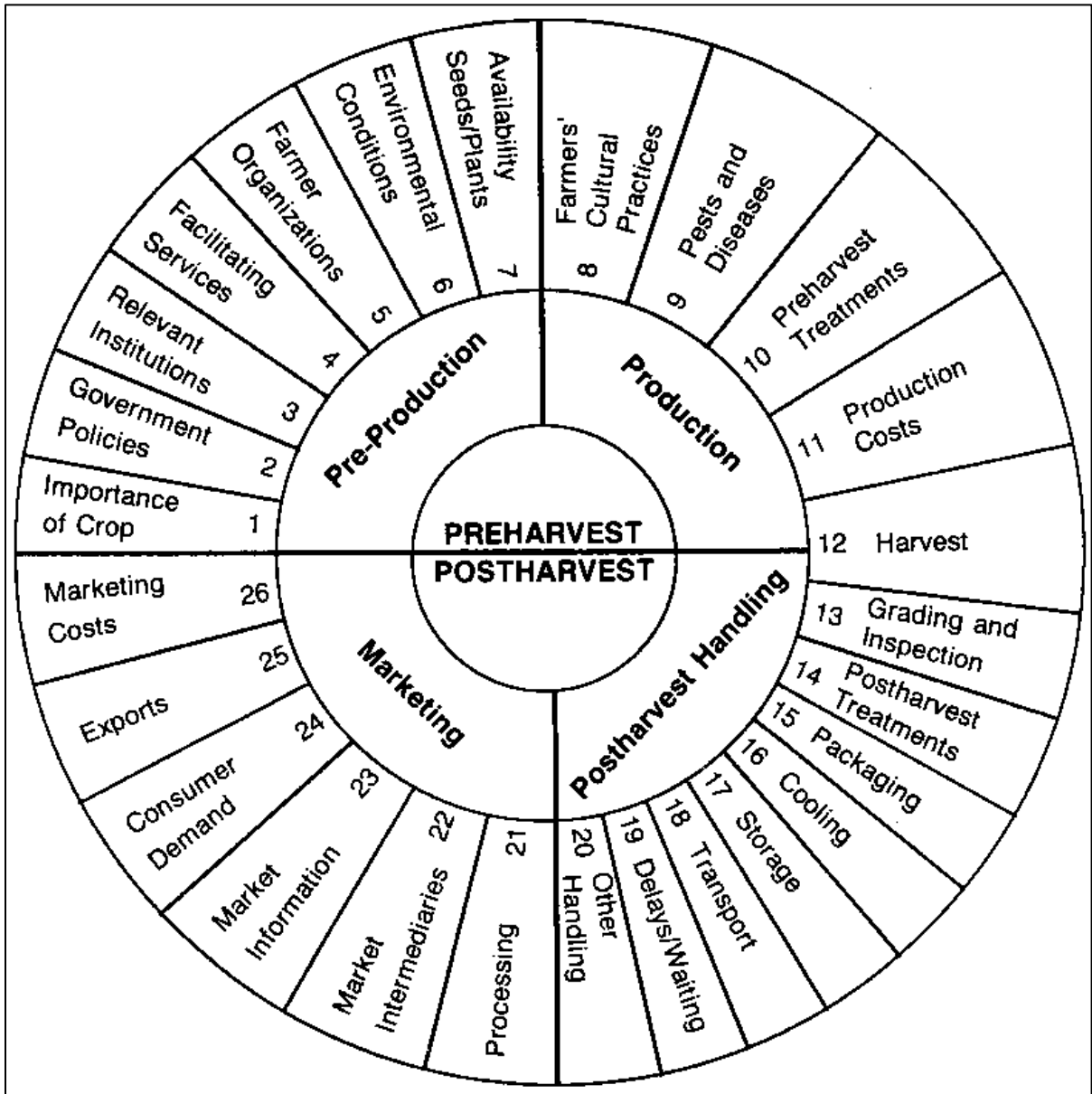
The 26 components of the Commodity System

Part 2: Visit the UN FAO website to access the complete CSAM manual in French or Spanish (LaGra 1990) and all the links to diagrams and tables:

Commodity Systems Assessment Manual

Spanish   http://www.fao.org/wairdocs/x5405s/x5405s00.htm

French   http://www.fao.org/wairdocs/x5405f/x5405f00.htm

Part 3: Please review the chapters of the CSAM manual, become familiar with all the components of the commodity system and take a look at some of the sample questionnaires that are used for collecting data for each component.

Expected Outcomes and End Results of Assignment #3:

Participants will gain familiarity with the concept of Value Chains, and with the CSAM process.

You will be designing and using your own simplified CSA questionnaires during the next assignment, so please review the items included in the examples to see what might work best for the crop(s) that you are interested in studying.

SELF-EXAM for Assignment #3

Completion date: _____

_____I downloaded the 2016 CSAM manual

_____I have reviewed the 26 components and the sample questionnaires in the annexes to prepare for Assignment #4.

I would like to learn more about the following topics:

Chapter 5
The CSA Report: Identifying priority research, extension and advocacy needs

The Commodity Systems Assessment Methodology (CSAM) manual is a very long and detailed document, complete with sample questionnaires for each component. It includes examples for many different crops and enormous lists of questions and ideas for creating locally specific assessments. It also provides many annexes and illustrations of tables and graphs as examples of how to organize and present data.

For the purposes of this postharvest e-learning program and assignment #4, it is more important to become familiar with the basic concepts and fieldwork practices involved in a CSA fieldwork experience, and it is not required to implement a full-scale CSAM study.

Assignment #4

Write a CSAM report on one key crop for your country

Part 1: Select one crop of interest, begin collecting data via **literature review** on the crop. Learn as much as you can on the 26 components by reading about the findings that others have reported on.

Continue your assessment to fill in any missing information via **interviews, observations, and field visits.** Speak with your colleagues and visit the library to read existing documents. You can ask some of the questions of farmers (those related to production), marketers (about postharvest handling and marketing), processors, traders, and others of researchers or extension workers (about the entire system).

Using the **summary list of CSAM questions** provided at the end of this chapter, and referring to list in Annex 4 and Annex 6 of the CSAM Manual for details, design your own **simplified survey** to collect key data related to your commodity. Select those questions related to the information you most want to find out more about.

It would be very helpful to collect data on the market prices in relation to the grades of the commodity. We will use this information in future assignments when using Cost/Benefit worksheets.

Consider who will be the best source of information for each type of question: for example, you should ask farmers the questions on production and on-farm handling practices, but ask traders about postharvest transport practices, and ask processors about food processing and packaging. You can ask market intermediaries or retail marketers about prices and consumer preferences. And you can ask extension agents who work with the crop questions related to all of the components.

Part 2: Prepare a brief report on CSA results for each of the 26 components of the commodity system. Describe your data sources and include references (if used). Data sources can be published articles or unpublished documents, review articles, interviews of stakeholders, observations or measurements.

Any data you collect should have some purpose—you should be able to explain what you plan to do with the information, and how knowing the facts might benefit the grower/marketers in your country. In later assignments, we will use this data to identify important issues, problems and opportunities for postharvest demonstrations and training programs or extension work and advocacy that can help reduce food losses in your community. If you have limited time, concentrate your efforts on the postharvest and marketing components of the report.

Try to organize your thoughts regarding each component, and answer the sample questions in order to identify problems that may affect postharvest losses and quality or food safety.

Part 3: Identify for the crop: Research needs, Extension needs and Advocacy issues.

The final part of the Report for Assignment #4 is the identification of specific needs for the crop. A descriptive report will be carefully read by a few stakeholders, but most people will want to read only your summary and a much briefer version of your report, focused on your findings and any recommendations.

Review and classify your CSAM findings into three categories, identifying:

- **Training Needs** (existing information that growers, handlers and marketers need to learn more about).

Example: providing information on maturity indices so growers will learn when to harvest for best quality and longer shelf life.

- **Research Needs** (problems that have no immediate solution, but require research experiments, adaptive studies or field trials).

Examples: a pest related postharvest loss for which no known treatment is available, or the use of a poor quality package compared to the use of an improved one.

- **Advocacy Issues** (needs that cannot be addressed by individuals, but that require the government or society to take a part in solving)

Examples: poor roads from the farm to the marketplace; need for increased funding for postharvest training programs.

Outline for a simplified CSA report

1) Title (including crop and country)

2) Your name as author (include your affiliation if desired)

3) Brief description of your methods and data sources (Did you make any field visits? Did you conduct interviews?)

4) Description of your findings for the 26 CSA components

5) Summary of the Research needs, Extension needs and Advocacy issues for the crop

6) Conclusions (what are the estimated % losses? what are the main causes and sources of losses?) and recommendations (what should be done?)

7) References

Sample CSA reports prepared by e-learning graduates on a variety of crops are provided for your review in the folder of training materials for this chapter. If there is any information that is not currently available or unknown for one or more of the components, you can make a note of this in your report.

An image, graph or chart can be a useful way to describe your findings. This simple illustration showing the steps of postharvest handling with estimates of % losses at each step is from the CSAM manual (redrawn from the original figure in La Gra, 1990).
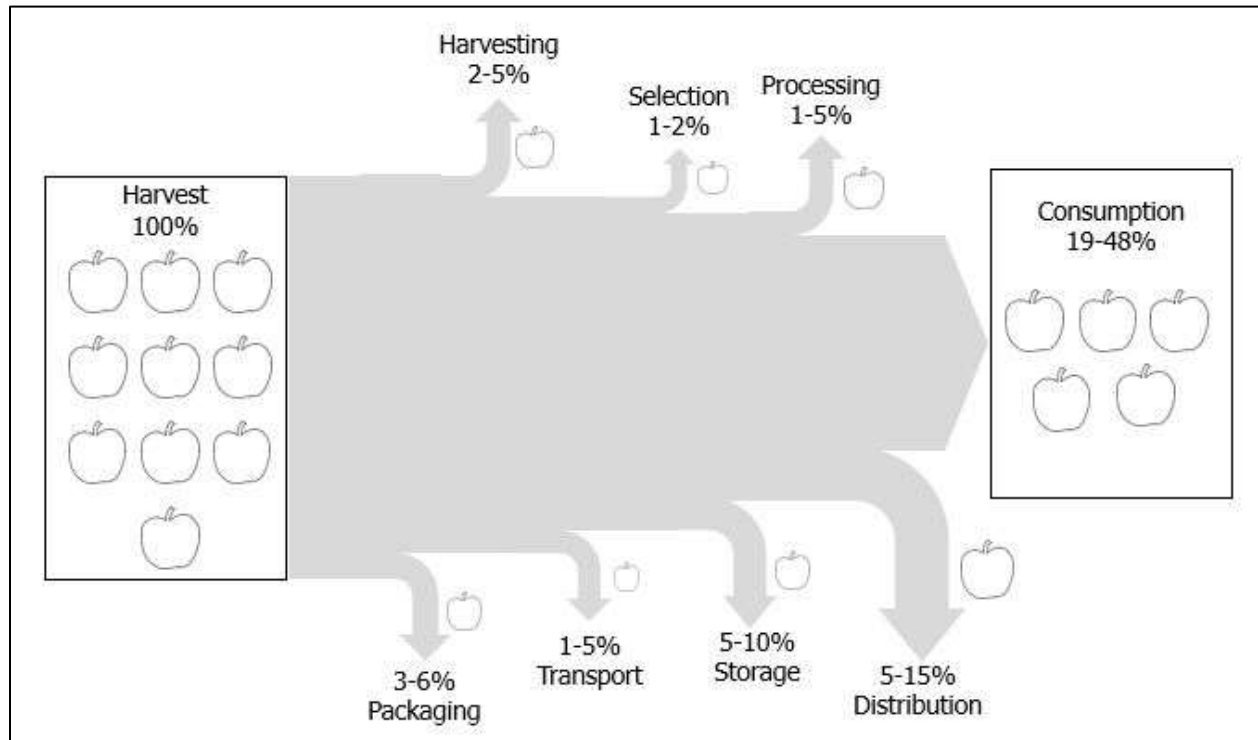
Summary list of key CSA questions:

Components 1 - 7: Pre-Production

1- Importance of the crop. What is the relative importance of the crop? Base your estimate of importance on information on number of producers, amount produced, area of production, and/or market value.

2- Governmental policies. Are there any laws, regulations, incentives or disincentives related to producing or marketing the crop? (e.g., existing price supports or controls, banned pesticides or residue limits). Is climate change affecting the commodity?

3- Relevant institutions. Are there any organizations involved in projects related to production or marketing the crop? What are the goals of the projects? How many people are participating?

4- Facilitating services. What services are available to producers and marketers (for example: credit, inputs, technical advice, subsidies)?

5- Producer/shipper organizations. Are there any producer or marketer organizations involved with the crop? What benefits or services do they provide to participants? At what cost?

6- Environmental conditions. Does the local climate, soils or other factors limit the quality of production? Are the cultivars produced appropriate for the location?

7- Availability of planting materials. Are seeds or planting materials of adequate quality? Can growers obtain appropriate and adequate supplies when needed?

Components 8 - 11: Production

8- Farmers' general cultural practices. Do any farming practices in use have an effect on produce quality (plant spacing, irrigation, weed control, fertilization practices, field sanitation)?

9- Pests and diseases. Are there any insects, fungi, bacteria, weeds or other pests present that affect the quality of produce? Is climate change causing more chemical usage? Is knowledge of these chemicals understood and proper usage followed?

10- Pre-harvest treatments. What kinds of pre-harvest treatments might affect postharvest quality (such as use of pesticides, pruning practices, thinning, trellising)? Are workers trained in using these practices or treatments?

11- Production costs. Estimate the total cost of production (inputs, labor, rent, etc.). What are the costs of any proposed alternative methods?

Components 12 - 21: Postharvest

12- Harvest. When and how is produce harvested? By whom? At what time of day? Why? What sort of containers are used? (Are they appropriately sized? Clean? Smooth?) Is the produce harvested at the proper maturity for the intended market? Example: do the farmers train harvesters to pick at certain ripeness (using color charts) or size? What % is lost or wasted?

13- Sorting, grading and inspection. How is produce sorted to remove damaged or diseased items? by whom? Is the produce graded by quality, color or size? Does value (price) change as quality/size grades change? Do local, regional or national standards (voluntary or mandatory) exist for inspection? What happens to culled produce? (For example: it could be sold at a lower price, fed to animals, or used to make compost.)

14- Postharvest treatments. What kinds of postharvest treatments are used? (Describe any curing practices, cleaning, trimming, hot water dips, etc.) Are treatments appropriate for the product?

15- Packaging. How is produce packed for transport and storage? What kind of packages are used? Why? Are packages appropriate for the product? Can they be reused or recycled?

16- Cooling. When and how is produce cooled? To what temperature? Using which method(s)? Is temperature and relative humidity (RH) measured during cooling? Are methods appropriate for the product?

17- Storage. Where and for how long is produce stored? In what type of storage facility? Under what conditions (packaging, temperature, RH, physical setting, hygiene, inspections, etc.)? Is the temperature and RH% measured while the produce is in storage? What % is lost or wasted?

18- Transport. How and for what distance is produce transported? In what condition are the roads (e.g. smooth or rough?) In what type of vehicle? How many times is produce transported? How is produce loaded and unloaded? What % is lost or wasted?

19- Delays/ waiting. Are there any delays during handling? How long and under what conditions (temperature, RH, physical setting) does produce wait between steps?

20- Other handling. What other types of handling does the produce undergo?   Is it unpacked/repacked into new containers? Is there sufficient labor available? Is the labor force well trained for proper handling from harvest through transport? Would alternative handling methods reduce losses? Would these methods require new workers or displace current workers?

21- Agro-processing. How is produce processed (methods, processing steps) and to what kinds of products? How much value is added? What % is lost or wasted? Are sufficient facilities, equipment, fuel, packaging materials and labor available for processing? Is there consumer demand for processed products?

Components 22 - 26: Marketing

22- Market intermediaries. Who are the handlers of the crop between producers and consumers? How long do they have control of produce and how do they handle it? What % is lost or wasted? Who is responsible for losses /who suffers financially? Is produce handled on consignment; marketed via direct sales; moved through wholesalers?

23- Market information. Do handlers and marketers have access to current prices and volumes in order to plan their marketing strategies? Who does the recordkeeping? Is information accurate, reliable, timely, and useful to decision makers?

24- Consumer demand. Do consumers have specific preferences for produce sizes, flavors, colors, maturities, quality grades, packages types, package sizes or other characteristics?   Are there any signs of unmet demand and/or over-supply? How do consumers react to the use of postharvest treatments (pesticides, irradiation, coatings, etc.) or certain packaging methods (plastic, Styrofoam, recyclables)?

25- Exports. Is this commodity produced for export? What are the specific requirements for export (regulations of importing country with respect to grades, packaging, pest control, etc.)?

26- Marketing costs. Estimate the total marketing costs for the crop (inputs and labor for harvest, packaging, grading, transport, storage, processing, etc.). Do handlers/ marketers have access to credit? Are prevailing market interest rates at a level that allows the borrower to repay the loan and still make a profit? Is supporting infrastructure adequate (roads, marketing facilities, management skills of staff, communication systems such as telephone, FAX, SMS, internet or e-mail services)?

_____

Source: Annex 4 of LaGra et al (2016).

Expected Outcomes and End Results of Assignment #4:

Participants will gain experience with the CSAM process and learn about one crop in great detail. It is expected that the same methodology can be used to study additional crops or as a baseline in order to assess the same crop again in the future (for example, after the conclusion of a postharvest project) to document any changes and improvements.

SELF-EXAM for Assignment #4

Completion date of Report 2 (CSA): _____

The crop that I assessed for my CSA report is _____

The location (country or region) I focused my report on is _____

_____ I described the 26 CSA components for the crop

_____ I identified the Research needs

_____ I identified the Extension/training needs

_____ I identified the Advocacy issues

Did you include all the 7 items in the outline in your report?   YES_____ NO ____

If you answered NO, then you need to revise and improve your report.

The **training/extension needs for my crop** (targeting the priority problems) include the following:

Chapter 6
Assessing the suitability of "best postharvest practices" and appropriate technologies

Assignment #5 is on the topic of Small Scale Postharvest Technology, and is a series of readings on low cost, simple technologies such as improved containers and packages, use of shade, Zero Energy Cool Chamber (ZECC), hermetic storage and food processing methods.

Resources (also provided via our shared GoogleDocs folder):

https://drive.google.com/open?id=0B5xzz3hIIS3qczRBNmlZbkZNbUE)

An enormous number of documents is provided for your reference. Additional files will be added as they become available.

General information, suitable for many different crops

Small-scale Postharvest Handling Practices: A manual for horticultural crops. 5th edition. (Kitinoja and Kader, 2015) – English only.
http://ucanr.edu/sites/Postharvest_Technology_Center_/files/231952.pdf

The 3rd or 4th edition is provided in English, French, Spanish and Arabic.

English: http://ucanr.edu/datastoreFiles/234-1450.pdf

Manual in an additional 10 languages is available on the UC Davis PTRIC website.

http://postharvest.ucdavis.edu/Library/Postharvest_Center_Publications/

Storage Training Manual. WFP (2011)

English:

http://documents.wfp.org/stellent/groups/public/documents/reports/wfp250916.pdf?_ga=1.204967 442.328273708.1473172696

French:

http://documents.wfp.org/stellent/groups/public/documents/reports/wfp256912.pdf?_ga=1.242011 392.328273708.1473172696

Energy Options for Horticulture (Winrock International for USAID)

http://pdf.usaid.gov/pdf_docs/PNADO634.pdf

Innovative Small-scale Postharvest Technologies for Reducing Losses in Horticultural Crops. Ethiopian J. Appl. Sci. Technol. (Special Issue No.1): 9-15 (2013).

http://ucce.ucdavis.edu/files/datastore/234-2584.pdf

Specific postharvest technologies (may be suitable for your crop of interest)

Plastic crates (PEF): Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. White Paper No. 13-01. La Pine, Oregon USA: The Postharvest Education Foundation. 26pp.

http://postharvest.org/RPCs%20PEF%202013%20White%20paper%2013-01%20pdf%20final.pdf

PICS bags for grain and dry bean storage (Purdue University)

https://agrilinks.org/blog/it%E2%80%99s-bag-story-purdue-improved-crop-storage-bag-pics

http://agtech.partneringforinnovation.org/servlet/JiveServlet/downloadBody/1561-102-6-1756/PICS%20Newsletter%20Volume%201%20Issue%201.pdf

Metal silos and Plastic tanks (WFP and Sasakawa Africa Association)

http://www.saa-feedingthefuture.org/pdf/FtF_2014_Dec_Theme2.pdf

Zero Energy Cool Chamber - ZECC (PPT summary presentation by SK Roy, Amity University, India)

http://ucce.ucdavis.edu/files/datastore/234-2143.pdf

Build your own ZECC (AVRDC)

12 min video (Swahili with English sub-titles) by Roseline Marealle

https://www.youtube.com/watch?v=ZUUVI8isvxU

Charcoal cool room (Chemonics International)

http://www.postharvest.org/images/CharcoalcoolstoragePNACQ751.pdf

Will evaporative cooling work in your climate zone?

http://www.easycalculation.com/weather/dewpoint-wetbulb-calculator.php

CoolBot™-- How to build your own walk-in cold room (Khosla, USA)

http://www.storeitcold.com

https://www.storeitcold.com/standing-guide/

The Porta-Cooler (USDA) and the Pack N Cool (NCSU) trailer: Pack n Cool article with links to video, photos, pdf and instructions

http://plantsforhumanhealth.ncsu.edu/2012/08/17/%E2%80%9Cpack-%E2%80%98n-cool%E2%80%9D-provides-farmers-with-mobile-refrigeration-solution/

http://ucanr.edu/datastoreFiles/234-2436.pdf

Principles and practices of fruit juice processing (FAO)

Bates et al (2001) FAO Bulletin 146. http://www.fao.org/docrep/005/y2515e/y2515e00.HTM

Please read and review each of these documents in order to familiarize yourself with the topics and recommended practices. These manuals and books are references, so you should consider them as useful resources to refer to again and again you work with new crops, or as things change over time for your clientele and they want to learn about and try out new technologies.

Assessing the suitability of any given technology or change in handling practice involves understanding the details, and reviewing — a few questions to consider:

- Will your clientele have the needed resources such as funds? local suitable materials?
- Will they have access to any needed purchased supplies?
- Does the technology or practice change fit the needs of their crop?
- Does it fit well into their current postharvest system?

Expected Outcomes and End Results of Assignment #5:

The participant will be introduced to many potentially useful practical postharvest handing practices and technologies.

The participant will become familiar with many of the resources used by postharvest specialists when they design and conduct training programs.

SELF-EXAM for Assignment #5

Completion date: _____

_____ I downloaded the manual "Small-scale postharvest handling practices" in the language of my choice.

The topics covered in this assignment that I found to be of most interest include the following:

The 3 postharvest technologies or improved handling practices that I most want to learn more about are:

Chapter 7

Determining the costs and benefits of using improved practices and technologies

One of the best extension methods for teaching people about appropriate postharvest technologies, and one of the best means for assessing suitability of a given technology is to calculate its local costs and expected benefits.

We have developed a simple worksheet that you can use to compare any two practices or technologies. To complete the Cost/Benefit Worksheet for your improved postharvest technology or new handling practice, **think simple and think small**.

Costs and benefits are estimations, and the idea is to provide just one example of how farmers or marketers can improve their incomes by using the technology or handling practice that you are teaching them about. By comparing the current or traditional practice to a new technology or practice that you want to demonstrate for reducing food losses, you can use actual local market prices and determine whether it will be cost effective or not. You should consider only those aspects (equipment, supplies, labor, etc.) that will be different, and ignore any costs that stay the same. The amount available for sale will depend upon your estimations of % postharvest losses.

Assignment #6

Report 3: Determining relative costs and expected benefits

Review the cost/benefit example for sweet peppers that is on the next page, and then try to complete one of the blank worksheets for your Report 3. Choose one crop and one postharvest practice change, and consider all the possible changes in costs and expected benefits. To learn how to use the worksheet, choose a simple practice change or a new technology, not something that is very complex (a complex change would combine many new practices and new technologies). The trick to using this simplified C/B determination method is to start with a simple unit (1000 kg of produce harvested) and ignore any cost that is the same for both practices. We are interested only in a relative cost difference (does one practice cost more to use than the other?) and the relative benefits (does one practice lead to higher earnings than does the other?) In our example for sweet

peppers, it costs a lot more to use plastic crates, but the returns (market value) is also much higher than for the traditional containers.

You may or may not have **recurring costs** to consider. In our example we can use the plastic crates many times, but we need to purchase new liners (heavy paper or fiberboard) with each use. This helps to protect the crop from abrasions and minimize food safety issues.

Sometimes the local **market price** will depend on quality or size (Grade 1, Grade 2, etc.), or the time of the year (glut time when there is over-supply or lean season when there is scarcity in the markets) so you may have more than one price to consider. Your new technology or handling practice may give you more Grade 1 than does the traditional or current practice, or it may provide more crop during the off-season when market prices are higher.

The return on investment (**ROI**) that you determine for the crop and technology combination may be negative or positive, and could be immediate or require several or many uses before you reach the break-even point. In this example for sweet peppers in plastic crates, even though the cost for plastic crates is very high, the new practice is immediately profitable with the 1st load because of reduced % losses and a higher market price per kg. A negative ROI would indicate that the technology is not a good choice for that crop or location at that time of year.

PEF POSTHARVEST COST / BENEFIT EXAMPLE WORKSHEET

Assume harvest = 1000 kg of sweet peppers   Example is in US$

Describe	Current Practice	New Practice
	Sacks for sweet peppers 25 kg	**Reusable plastic crates plus fiber-board liners 12.5 kg**
COSTS:		
40 sacks @ $0.50	$20	
80 crates @ $6.00		$480
Crate liners @ $0.10		$8
Relative cost	$20	$488
Recurring costs	$20	$8
EXPECTED BENEFITS:		
% losses	30%	5%
Amount for sale	700 kg	950 kg

Describe	Current Practice	New Practice
	Sacks for sweet peppers 25 kg	Reusable plastic crates plus fiber-board liners 12.5 kg
Value/kg	$1.00/kg	$1.25/kg
Total market value	$700.00	$1187.50
Market value – costs =	$680.00	$699.50
Relative profit 1st load*		+ $19.50
Relative profit 2nd and subsequent loads		+ $499.50
ROI		= 1 load of 1000 kg

Notes: * one load is 1000 kg

In this example, even though the cost for plastic crates is very high, the new practice is immediately profitable with the 1st load. Once the plastic crates have been paid for, the relative profit will increase to +$499.50 per load of 1000 kg. Plastic crates can be reused more than 100 times, while sacks are used only once.

How do you estimate the changes in % losses?

Traditional (current) practices and technologies have been documented to cause high postharvest losses, in some cases as high as 50 to 80%. The main causes of high losses for perishable crops are poor quality containers, rough handling, high temperatures during the postharvest period, and delays in marketing. The main causes for high losses of grains, dry beans and other staple crops include spillage during harvesting, poor drying practices, and inadequate storage containers or structures (lack of protection from pests, heat, rain or moisture).

Improved practices and technologies can greatly reduce these losses. Using plastic crates can reduce damage and losses of fresh produce to less than 5%. Cool storage of perishable and proper dry storage for staples can reduce losses by half or even more, depending on the crop. You can refer to the manuals and resources provided in Chapter 6 for additional examples.

Assignment # 6

Complete one Cost/Benefit Worksheet for the crop and postharvest technology or practice change of your choice (Report 3).

Three blank C/B Worksheets are provided in this chapter for you to use to practice on additional crops, technologies and market prices.

In each case, always begin with 1000 kg of the harvested crop – this makes the math easy to do. If you have more or less crop to work with, then after the worksheet is complete you can adjust the amount. For example if you have 2000kg at harvest, you can multiply the results by 2. If you have only 500kg at harvest, you can divide the results by 2.

PEF COST BENEFIT WORKSHEET

Assume harvest 1000 kg   Crop_____   Country/Region_____ Date_____

Use your local currency   _____ = $US1

Describe:	Current Practice	New Practice
COSTS		
Relative cost		
Recurring costs		
EXPECTED BENEFITS		
% losses (estimation)		
Amount available for sale		
Value/kg		
Total market value		
Market value minus relative costs		
Relative profit		
ROI How many loads does it require to reach 100% Return on Investment?		

* one load is 1000 kg to make the calculations simple

To complete the C/B worksheet for your postharvest technology, remember to think simple and small. Costs and benefits are estimations, and the idea is to provide just one example of how

farmers can improve their incomes by using the new technology or practice change that you are teaching them about.

For additional C/B examples, please refer to some of the completed worksheets from the field trials of a 2009-10 WFLO project for the Bill and Melinda Gates Foundation which can be found in the GoogleDocs folder of training materials for this chapter.

https://drive.google.com/open?id=0B5xzz3hIIS3qX1lLVTl1QVNvTzA

PEF COST BENEFIT WORKSHEET

Assume harvest 1000 kg   Crop_____   Country/Region_____ Date_____

Use your local currency   _____ = $US1

Describe	Current Practice	New Practice
COSTS		
Relative cost		
Recurring costs		
EXPECTED BENEFITS		
% losses (estimation)		
Amount available for sale		
Value/kg		
Total market value		
Market value minus relative costs		
Relative profit		
ROI How many loads does it require to reach 100% Return on Investment?		

* one load is 1000kg to make the calculations simple

Expected Outcomes and End Results of Assignment #6:

The participant will learn how to calculate relative costs and expected benefits for postharvest technologies.

SELF-EXAM for Assignment #6

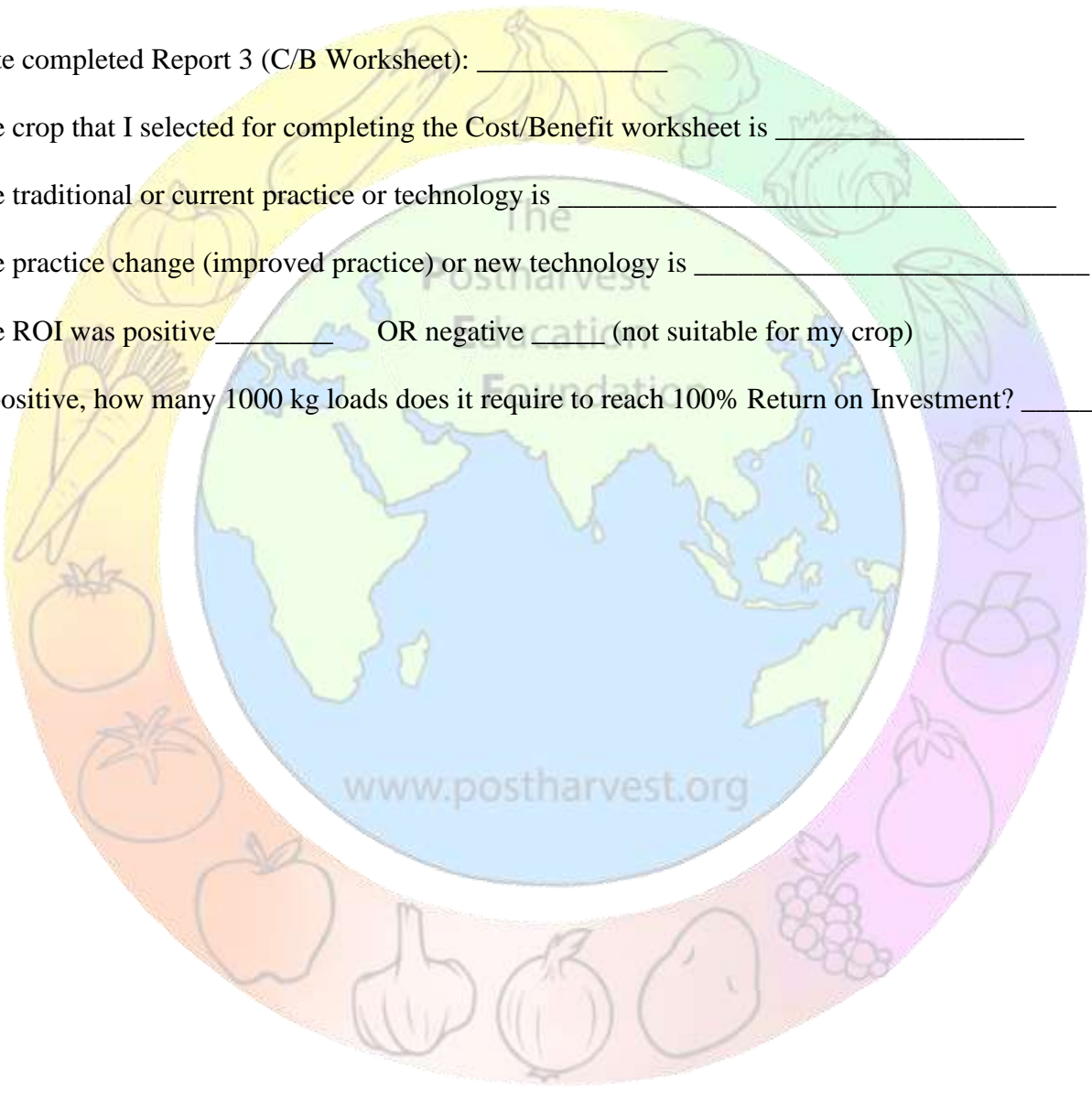Date completed Report 3 (C/B Worksheet): _____

The crop that I selected for completing the Cost/Benefit worksheet is _____

The traditional or current practice or technology is _____

The practice change (improved practice) or new technology is _____

The ROI was positive_____ OR negative _____ (not suitable for my crop)

If positive, how many 1000 kg loads does it require to reach 100% Return on Investment? _____

Chapter 8
Designing postharvest demonstrations for local farmers, traders, food processors and marketers

Demonstrations are one of the easiest extension methods for teaching people about new ideas, postharvest handling practices or postharvest technologies. Examples are provided in this chapter, each of which can be visited in Arusha, Tanzania at the PTSC that has been established at the World Vegetable Center (AVRDC).

1) Use of shade

Providing shade for fresh produce after harvest helps to reduce the pulp temperature and extend shelf life, and is a quick and easy demonstration. Participants are shown how to measure the pulp temperature of produce after it has spent a few hours in the sun, and compare this to the cooler temperatures of the same produce that has been kept in the shade. Measuring changes in produce weights after a few hours in the sun will demonstrate loss in profits if produce is sold by weight.

As a general rule of thumb, a decrease in produce temperature of 10°C will extend potential shelf life by 2 times (double). For example, tomatoes handled at ambient temperature of 30°C will have a shelf life of 4 days, while at 20°C they will maintain good quality for 8 days.

A green 60% PolyNet shade cloth was designed in India and donated to the PTSC by Amity University (brought to Tanzania by Dr. SK Roy in October 2012) The estimated value of the shade cloth was US$50. AVRDC installed the 6 wood poles that hold the shade cloth. (Total cost = $ 100.) This shade cover can be adjusted as the sun moves, and is tied to the poles and staked to the ground. Each pole is covered with a simple wrap made from old sacks to prevent damage from the rough wood rubbing against the cloth. The corners are reinforced with sacking materials (wrapped around the wooden poles) to prevent damage to the cloth.

A white or light colored shade cloth would decrease the temperature in the shaded area even more than a dark colored shade cloth. This simple white PolyNet shade cover is used in India for packing crops after the harvest.

Dr. S K Roy and Dr. Sunil Saran demonstrating the PolyNet shade cover for farmers in India

A traditional shade cover made with wood poles and a thatched roof was constructed on site at the PTSC by Tanzanian carpenters and thatch workers. (Total cost = $144.00)

2) Harvesting tools and equipment

A variety of simple tools are provided for this demonstration, including harvesting clippers, hand-held pruners, a picking basket on a long pole, harvesting bags that can be worn during picking, and color charts for visual determination of proper maturity for various fruits and vegetable crops.

Harvesting bags are designed to have a bottom that opens easily and allows produce to be gently transferred from the bottom of the bag into a container in the field, in order to prevent the usual damage that comes from dumping produce, emptying large containers, dropping or throwing produce into piles on the ground after harvest. The bags can be used to harvest maize, dry beans, fruits, tomatoes, peppers and many other crops.

Harvesting bags can be purchased from many companies in the USA for $25 to $40 per bag. Patterns and instructions are provided at the PTSC for making low cost harvesting bags using local materials.

3) Improved packages, containers and packaging materials

A variety of traditional and improved containers and packages for handling harvested produce, such as wooden crates, plastic crates, sacks, baskets, package liners, smaller sized containers are available for demonstrations at the PTSC.

Hand dollies are demonstrated for moving plastic crates. The wooden crates used in Tanzania are generally rough and very large (holding up to 50 kg) so several examples of improved locally made packages were developed, including half sized crates, smooth wooden crates (sanded inside) and liners for crates.

Studies have shown that simply by decreasing the size of large packages (crates, sacks or baskets) damage to produce can be greatly reduced (Kitinoja, 2010). Field trials in Tanzania have shown that tomatoes suffer 50% damage when shipped in rough wooden crates—this can be reduced to less than 5% by using crate liners, smaller crates or plastic crates.

Types of plastic crates (nestable, left); Stackable crates (middle) are very sturdy and long lasting; Foldable crates (right)

Radegunda Kessy (PEF E-learning graduate) in Tanzania showing different types of crates and cartons

4) Grading/packing stations

Stainless steel work tables of high quality are part of the PTSC design in Arusha, and so sorting, grading and packing is an easy demonstration to mount. These tables are long lasting, easy to keep clean and can be rearranged as needed for providing training on manual color and size sorting, quality grading and improved packing practices. Simple tools for these demonstrations include color charts, hand-held sizing rings, calipers, rulers and quality measurement tools (i.e. refractometer, quality rating charts).

5) Washing and postharvest treatment stations

A stainless-steel sink with apron and detachable hose for washing demonstrations is included as part of the PTSC in Arusha.

Postharvest demonstrations include:

- hand washing (equipped with soap, running water, a clean cotton towel for hand drying, and hand washing poster)
- plastic trays with drainage holes for use in spraying produce to wash off soil or to treat produce via water based sprays after harvest with approved fungicides
- washing/scrubbing produce before processing
- cleaning hand tools, trays, pots and other processing equipment after use
- cleaning and sanitizing plastic crates between uses

Stainless steel sink and counters for washing in the PTSC in Arusha, Tanzania.

Handwashing poster link:

https://s-media-cache-ak0.pinimg.com/originals/93/89/99/9389995d3df6717117c81b423c939710.jpg

6) Evaporative cooling

A set of demonstrations on evaporative cooling can be provided using a few simple tools that are available at the PTSC, including a small hand-held battery powered fan, a fiber pad (aspen wood fiber, straw or poly-cellulose fiber) and a digital temperature probe or wall thermometer.

Most rural people in Tanzania were unfamiliar with temperature measured in degrees or with thermometers, so explaining cooling with numbers is not a useful teaching practice. However, simply by wetting the sample fiber pad and letting the trainees feel how the air pushed by the fan is

much cooler than the ambient air when it touches their hand is enough for them to understand how the process works.

A portable evaporative cooling demo unit made with a larger stand-up fan, a water pump equipped with a solar panel that provides electric power and an aspen wood fiber pad can be set up on sunny days to pre-cool a batch of fresh produce in plastic crates set in front of the unit.

A simple, portable evaporative cooling demonstration

7) Zero Energy Cool Chamber (ZECC)

A low-cost brick and sand evaporative cool chamber, known as the ZECC, is one of the demonstrations at the PTSC in Arusha, and includes 6 medium sized plastic crates to hold stored fresh produce and a thatched shade cover on wooden poles to protect the ZECC from direct sun and reduce heat gain from solar radiation. The ZECC demo is set up in an outdoor space where it is safe from flooding, and where air can freely move around the outside of the chamber to help carry away heat via the principal of evaporative cooling.

The cost of this demo unit (the ZECC, 6 crates and small shade structure) is approximately $600, and the cool chamber can store 100kg of fresh produce, keeping it fresh for up to one week during times of the year when the relative humidity of the ambient air is lower than 60%. This storage structure works especially well in arid and semi-arid regions, during the dry season in other regions, and in locations where night time temperatures are much lower than day time temperatures (mountain zones or at higher altitudes such as in Arusha). The cost of the unit can be much lower if the kiln fired bricks are made by the farmers, if clean, coarse sand can be obtained from a local river bottom, and/or if the thatch is harvested and the roofing materials are made on farm.

The PTSC at AVRDC has two ZECCs on site -- one is used for training on ZECC construction. For each program, it can be taken apart into its components and the same materials used to teach the next group of trainees how to construct their own ZECC. The two ZECCS can also be used for conducting comparative research studies, for example, to compare side by side a variety of alternative handling practices, crops, containers, or storage management practices.

Demonstrations of the ZECC

8) Small insulated cold room equipped with a CoolBot™ controller

The PTSC is equipped with a 3m by 4m cold room as part of the design. The room was built using the traditional local mud bricks for walls and plastered with cement inside and outside. The inside walls are insulated with two layers of double-bubble reflective sheeting (R6 for each layer) that have been applied to the walls using silicone construction grade adhesive. The height of the room is 2.5m, and the ceiling of the inside of the room is also insulated, and has a covered fluorescent

light fixture (for food safety). The door is a plain wooden door with a heavy layer of insulation on the inside and a plastic strip curtain on the outside. The top of the cold room ceiling is covered with another layer of reflective insulation sheeting, and the room sits under a large metal roofed shade cover.

The cooling system for the room is a simple window style air conditioner (12,000 BTU) equipped with a CoolBot™ unit that overrides the thermostat and allows the unit to cool the room to 12°C for demonstration purposes, and to as low as 2°C if desired. The air conditioner is stripped of its inner cover to allow better air flow, and the CoolBot™ unit is plugged into the wall socket, attached to the A/C as per the simple instructions and can be regulated with a touch of the buttons.

Demos include instruction on installation assisted by a video provided by the manufacturer.

https://www.storeitcold.com/install-your-coolbot/ (video)

https://www.storeitcold.com/standing-guide/ (notes and tips on cold room construction)

Inside the cold room are demonstrations showing the use of wood pallets to keep produce off the floor, and outside there are posters illustrating the recommended temperatures, relative humidity and commodity compatibility for temporary storage of many kinds of fresh produce.

9) Portable FA cooler

A demonstration unit for forced air cooling is installed at the PTSC in Arusha. The unit is made of local materials (a small electric fan with a simple wood box housing made by a local carpenter, a small plastic tarp and wooden strips to hold the tarp open when the air is being pulled through the crates to cool the produce. The cost is approximately $200. The roll-out tarpaulin cover can be adjusted to cool 4 or 8 crates as needed. This portable FA demo unit is designed to be used inside the cold room. (The cold room requires an extra electric outlet in order to plug in the fan).

Portable forced air cooling tunnel

The arrangement of the crates is an important part of the demo, and the flow of air through the crates can be adjusted by adding liners to the crates or by covering some of the vents. An empty "tunnel" is made in the center of the FA cooler by stacking the crates in two even rows. A larger version of the portable forced air cooling tunnel can be installed in a cold room as a demonstration, if resources permit, as illustrated below.
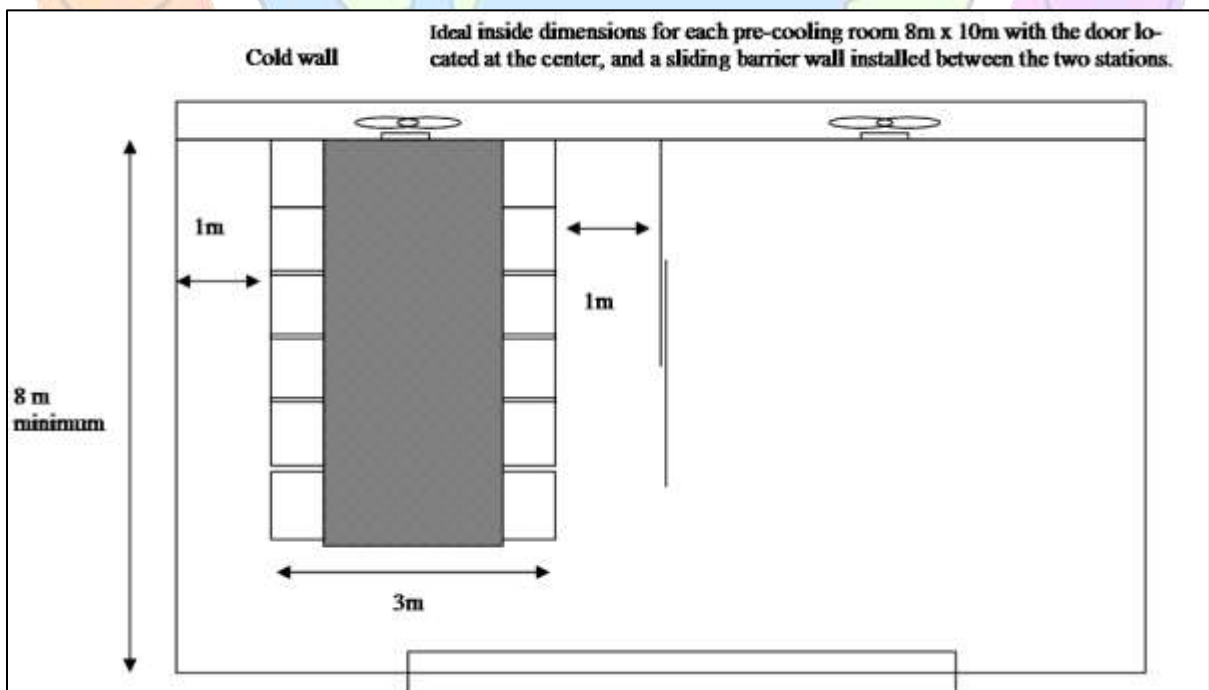
10) Small scale processing equipment and packaging supplies

A large array of food processing equipment and tools are provided for conducting simple demonstrations on small scale canning methods, jam and jelly making, bottling and candy making at the PTSC.

Basic equipment includes cooking pots, strainers, colanders, large spoons, spatulas, knives, cutting boards, and trays. Two types of cook stoves are available for demonstrations and training, a one burner Rocketstove™ (with instructions for construction of locally made versions), and a large propane powered stovetop unit with propane tank. http://www.rocketstove.org/

Supplies for training include different types and sizes of jars, bottles, cheesecloth for straining, simple preservatives, sugar, and spices. Tools used for demonstrations of quality control include a honey refractometer, high temperature thermometers and litmus paper. Training materials for Food safety practices include aprons, hair and beard nets and food safe gloves.
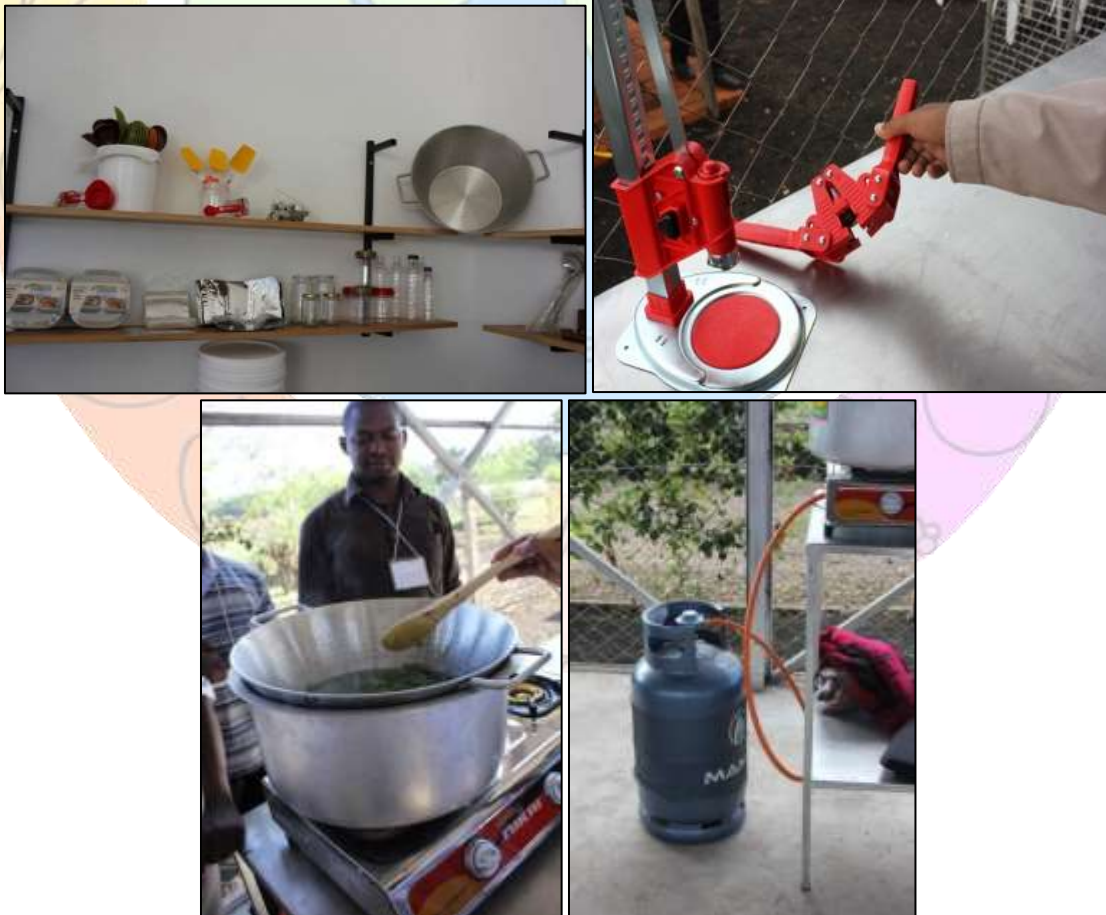
11) Improved solar driers and packages for dried products

The traditional 6 tray solar dryer used in Tanzania is a direct type of dryer, developed many years ago by NRI (UK) and disseminated throughout east Africa. The PTSC has two of these simple driers, along with a solar concentrator made of stainless steel sheeting to reflect and focus sunlight into the unit and help improve drying efficiency during cool or cloudy weather. The solar concentrator is based on a Hort CRSP exploratory project (Stiling et al. 2012). A second "indirect" style solar drier is set up at the PTSC for demonstration purposes – it is a cabinet design with a solar collector (a large flat box with a black bottom and a glass top).

Reflector added to a simple direct dryer, and improved indirect cabinet dryer with solar collector (still needs to have a chimney added)

Improved packages for dried food products are also part of the solar drying demonstrations. Several types of packages are provided for illustrative purposes (plastic bags, plastic jars with screw lids, glass jars, plastic buckets in small to large sizes), and food grade plastic bags and metal foil pouches are provided for the trainees to package the products they make during the training (see photos below).

Assignment #7: Design a postharvest demonstration

Choose one topic from the CSA **postharvest extension or training needs** that you identified in Report 2 for Assignment #4. Choose **one clearly identified** technology such as those described above, that could help to solve the problem or address the training need (for example: a cooling method, an improved kind of package, or a food processing method).

Design a simple postharvest demonstration to target the problem and provide a solution, including cost/benefit (C/B) information to convince users of its usefulness for reducing losses and improving incomes when used for handling their crop.

To complete the C/B Worksheet for your postharvest technology, remember to think **simple and small**. Costs and benefits are estimations, and the idea is to provide just one example of how farmers or food handlers can improve their incomes by using the technology that you are teaching about.

Prepare a brief report for **Assignment #7** on your demonstration idea.

Outline for **Report 4: Postharvest Demonstration**

1) brief **statement of the problem** that will be solved by the demonstration

2) brief **description of the target audience** for your demonstration

3) list of **tools and supplies** needed to set up the demonstration

4) the intended **demonstration results** (reduction of postharvest losses? improvement in income?)

5) completed worksheet on the **costs and benefits** for the user (a blank C/B Worksheet is provided on the next page for you to use to compare the current practice to the demonstrated improved practice).

PEF COST BENEFIT WORKSHEET

Assume harvest 1000 kg   Crop_____   Country/Region_____ Date_____
Use your local currency   _____ = $US1

Describe:	Current Practice	New Practice
COSTS		
Relative cost		
EXPECTED BENEFITS		
% losses (estimation)		
Amount available for sale		
Value/kg		
Total market value		
Market value minus relative costs		
Relative profit		
ROI How many loads does it require to reach 100% Return on Investment?		

* one load is 1000kg to make the calculations simple

To complete the C/B worksheet for your postharvest technology, remember to think **simple and small**. For training purposes, try to use a simple example, one without any recurring costs. Costs and benefits are estimations, and the idea is to provide just one example of how farmers can improve their incomes by using the technology you are teaching them about.

If the farmers or food processors are very small-scale, it may be useful to complete the worksheet for your demonstration using only 100kg for the load size (rather than 1000kg).

Expected Outcomes and End Results of Assignment #7:

Participants will gain experience in designing a postharvest demonstration, including the generation of information on its relative **costs** and expected **benefits**.

SELF-EXAM for Assignment #7

Date completed Report 4 (Postharvest Demo): _____

The crop that I selected for the postharvest demonstration is _____

The target audience is _____

Their traditional practice or technology is _____

The practice change or new technology I selected for my demo is _____

Did you include all the 5 items in the outline in your report?   YES_____ NO _____

If you answered NO, then you need to revise and improve your report.

The ROI in my C/B Worksheet is positive_____

OR negative _____ (not suitable for my crop)

If the ROI is positive, how many 1000kg loads does it require to reach 100% Return on Investment? _____

Chapter 9
Setting measurable goals and objectives for a postharvest training program

Typically, a program will have the following spelled out during the proposal and planning stages.

Mission: your purpose and grand plan for the future. (Ex: No more food insecurity on Earth!)

Goals: the long-term achievements of your postharvest training program.

Example: To reduce food losses and thereby improve incomes for participants in the program so they can be food secure and healthy.

Objectives: a measurable set of steps or actions that will help you reach your goals.

Example: To provide postharvest training for farmers in order to help them to learn new postharvest handling practices for their crops that will reduce food losses and increase their incomes.

Theory of Action (also known as results chain or program logic): a chain of activities and/or events that can take us from where we are now to where we want to be and therefore achieve our project objectives. A theory of action uses "If-Then" logic.

Example: the current levels of high postharvest food losses will be reduced if the training provided by the program reaches people who learn enough to then make practice changes and adopt new postharvest technologies, and then these new practices help them to reduce food losses and gain higher earnings from selling their crops.

Two PowerPoint presentations on the topic are provided in the folder for this assignment. Please review.

Assignment #8: Writing Measurable Objectives

Your project/program title _____

Write three examples of **a measurable objective** for the postharvest training program

1)

2)

3)

Reminder:

Measurable objectives include

- **indicators** or things you can count (such as numbers of sites or people to be reached, numbers of postharvest topics or technologies to be demonstrated)
- **targets** (the goal of having a certain number of people making practice changes, or measuring a specific change in % losses)
- with a **timeline** (such as the number of participants per week or per year).

Expected Outcomes and End Results of Assignment #8:

Participants will be introduced to the concepts of mission, goals and objectives.

Participants will learn how to write a measurable objective for a postharvest training program.

SELF-EXAM for Assignment #8
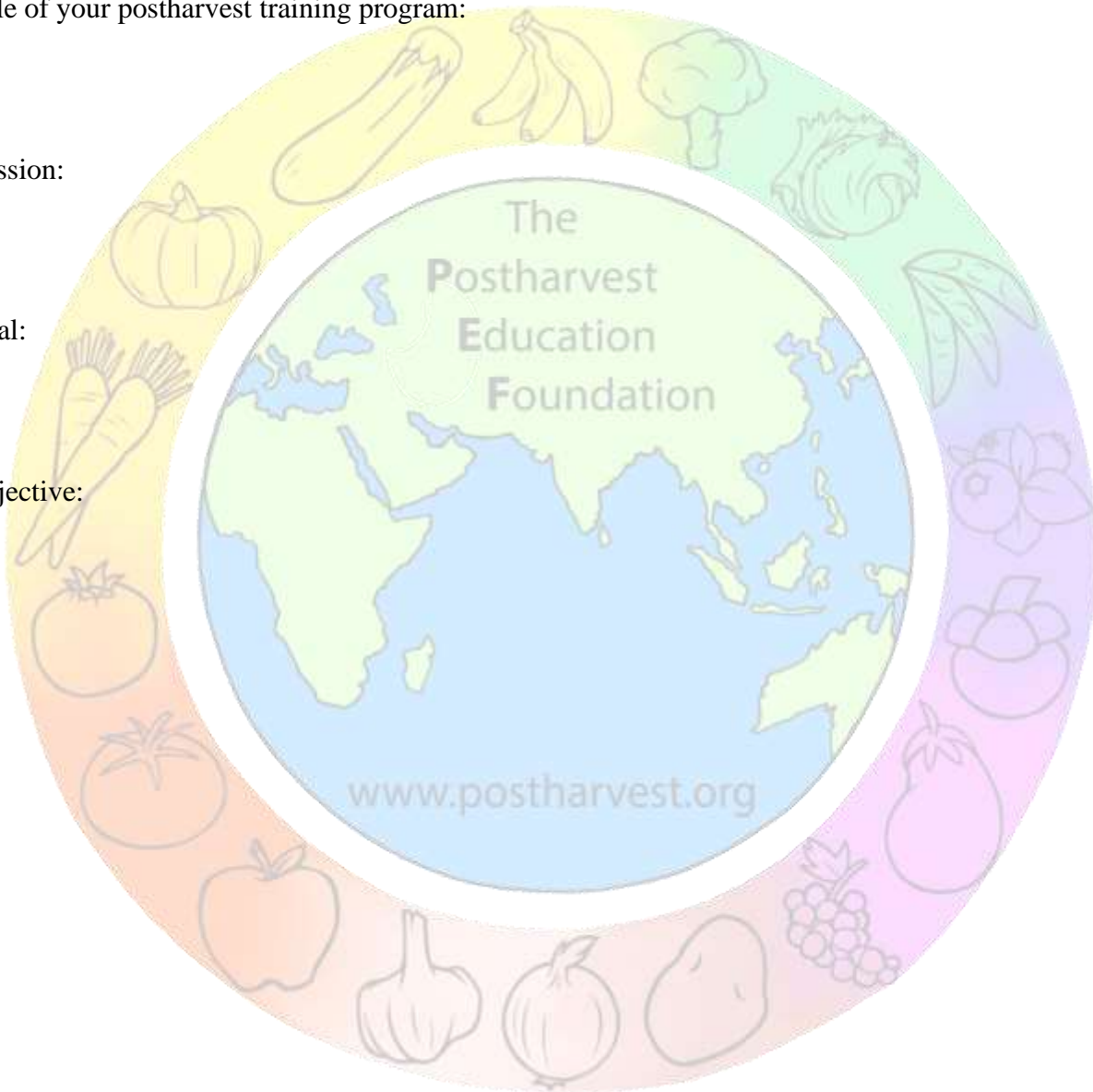
Date of completion: _____

Have some fun and use your imagination to write your own mission, a goal and an objective.

Title of your postharvest training program:

Mission:

Goal:

Objective:

Chapter 10
Using postharvest extension methods, tools and equipment for quality assessment and as training aids

The readings for Assignment #9 can be accessed online via our shared Google Drive folder.

Assignment #9

Topic 1: Extension Methods for Postharvest Horticulture

Readings:

Review the Horticultural Extension Manual (Kitinoja, 2002)

Chapter 38 of Postharvest Horticulture UC ANR 3311 UC Davis textbook (2002).

Topic 2: Using tools and equipment for quality assessment and as training aids

Readings:

Manual on Postharvest Tools and Supplies Kit

Read the excerpt from HS23 (Introduction to Quality Rating Scales)

Check out the examples of color charts, rating scales, and other tools.

Videos by Dr. Diane M Barrett (UC Davis emeritus and PEF Board of Directors)

- Using a refractometer https://www.youtube.com/watch?v=h1V7zqwMjrQ
- Making color charts https://youtu.be/ufF2iPeAaeY
- How to measure temperature and relative humidity https://youtu.be/8b3v0ky3OkQ

A Postharvest Tool Kit contains some modern tools:

- digital temperature probe
- quality/maturity/color rating charts
- digital scale (5 kg capacity)
- refractometer
- chlorine test strips
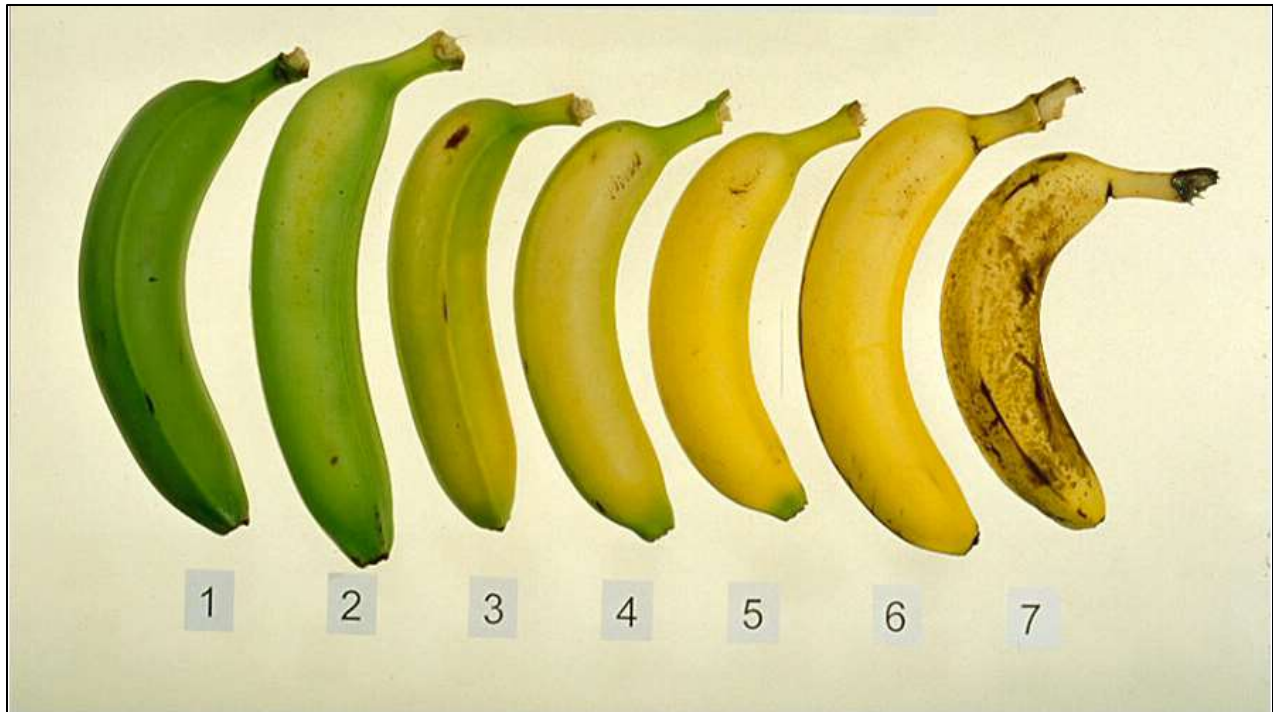
Banana ripeness chart (Source: UC Davis)

Some of the tools in the kit can be modified and custom made as needed in your country:

- sizing rings for different crops (cut from aluminum or wood sheets, or made from thick wire using different sized templates)
- color charts for locally produced crops (from photos you can take of local varieties of fruits at different maturity stages or vegetables in different stages of development)
- quality rating charts

Example: SIZING RINGS

Design Options and Materials Needed

Flat blade style sizing rings: Single or multiple size hand held sizing blades can be purchased readymade for $US5 to 10 each or fashioned as needed from sheet metal, 3mm flexible plastic or thin solid wood sheet (about 1/8th inch thick). The size of the holes should be determined by the type of fruit or vegetable to be graded by size.

Wire rings: Medium gauge wire (10g to 12g copper solid core coated wire or aluminum wire) can be used to make sizing rings of any size needed for $US1 each or less. The strong wire can be cut to length, and using pliers and a round fixed object as a mold, twisted to make the shape shown below. This simple style sizing ring can be easily grasped with two fingers and used to assess the size of many types of produce. A small piece of PVC pipe, a soup can or a can of beans make inexpensive molds, and are readily available in 60mm, 70mm, 85mm and 100mm outside diameter widths.

Participants who enrolled in PEF's annual Global Postharvest E-learning Program and paid a $300 registration fee were eligible to receive a free tool kit. Only those participants who completed and submitted all assigned reports received a Postharvest Tool Kit. For participants or lead instructors who are interested in making tools or purchasing postharvest tool kits, please visit the website: www.postharvestinnovations.com

Expected Outcomes and End Results of Assignment #9:

Participants will learn about the many kinds of tools used by postharvest specialists for postharvest loss assessment and quality measurements.

SELF-EXAM for Assignment #9

Date of completion:

List 3 postharvest tools that you are interested in learning more about:

1.

2.

3.

List 2 postharvest tools that you would like to own and use in your studies or your work.

1.

2.

List 2 postharvest tools that you can make for yourself

1.

2.

If you make a tool for yourself, **please take a photo, and share** it with our PEF network via our Facebook page or on our LinkedIn discussion pages.

Chapter 11

Designing local postharvest training programs for various audiences and clientele groups

The previous chapters of this manual have provided a look into all kinds of postharvest problems and potential solutions. The purpose of becoming a postharvest specialist is to be able to use these new knowledge and skills to design the most appropriate training programs for local audiences. These training programs will be able to provide field tested information on cost effective practices or technologies that are intended to help participants learn about improved postharvest practices that will help to increase their earnings by reducing food losses and/or adding value to their fresh agricultural produce or processed products.

Assignment #10

Design a one day long postharvest training program for your clientele. Choose any of the postharvest practices or technologies that were covered in the training materials you read in the Manual or learned about during Assignment #5 or in the list of demonstration ideas provided in Chapter 8.

A PowerPoint presentation is considered an audio-visual training aid because you provide both something to look at and a written and oral explanation. For example, you can take one slide from your PowerPoint (one that looks like it would make a good poster, with a nice photo or illustration and a few words or bullet points) and translate the slide into your local language for the report.

A sample report is included in the folder of training materials for this assignment for reference. Please do not select the same topic as covered in the sample report.

Prepare a report on the training program which includes the following sections:

1) Title of the training event

2) Your name and affiliation

3) Agenda (maximum of one day)

4) Learning Objective(s)

5) Audience (location, types of target groups and numbers of each)

6) Resources needed (number and type of instructors, training materials, tools, equipment, catering, transport, marketing/advertising the program, etc.)

7) Outline of the training to be provided, with technical information, details on the demo(s) to be included, and a sample audio-visual training aid.

8) Costs and benefits of adopting the recommended postharvest technology or technologies -- use the C/B worksheet for each

9) Expected learning outcomes

10) Draft budget for the training program

Prepare your budget as if it were part of a proposal that you wish to submit for funding. Try to find reasonably priced venues, resource people and training materials. Do not include items such as a computer, or expenses for flying an expert in to work with you, but do include any expendable supplies needed for conducting a **one day program**.

Expected Outcomes and End Results of Assignment #10:

Participants will learn how to write a brief report describing their detailed plan for a postharvest training program, including an agenda and a draft budget.

SELF-EXAM for Assignment #10

Date completed Report 5 (Training program design): _____

Title of your program_____

Did you include all the 10 items in the outline in your report?   YES_____ NO _____

If you answered NO, then you need to revise and improve your report.

What is the total budget for your program? _____

How many people do you plan to train? _____

What is the cost per person for your program? Total budget/number of trainees = _____

Chapter 12

Evaluating the effectiveness of postharvest training programs

Monitoring and Evaluation (M&E) practices for postharvest training programs and projects are a very important part of any postharvest project. Often this step is missing from the program or is done in a perfunctory manner when financial resources are limited.

Why do we want to monitor and evaluate postharvest projects and programs?

- Accountability purposes/may be required by donors
- Making program improvements
- For future project planning/proposal development

Typically, we want to **measure changes** that can be attributed to the program or project, so we need a BASELINE measurement of INDICATORS to characterize the current situation.

Examples of important changes in postharvest training programs include:

- having new interests or aspirations
- gaining new knowledge
- learning new skills
- adopting new practices
- investing in new technologies
- accessing new sources of income
- measuring changes in % food losses

Changes can be positive or negative, intended or unintended. Sometimes a change can lead to a negative effect, such as when women who process foods manually are replaced by a machine.

A **theory of action** or **logic model** can help us to attribute any measured changes to the program's activities (using **if-then** logic) as described in Chapter 9. In our own case for this PEF ToT program, we compare the results of a TNA survey for our e-learners conducted at the end of the program with the one they completed at the beginning. Example: **If** our e-learners gain new knowledge and skills, and apply their knowledge/skills to provide postharvest training programs for their community, **then** local trainees will gain new knowledge/skills and adopt new postharvest

practices. **If** new postharvest practices are adopted, **then** food losses will be reduced and participants will increase their incomes.

Including **STAKEHOLDERS** in the M&E planning and implementation process will improve the chances that the evaluation results are utilized for decision making and future planning.

OUTPUTS are under the direct control of the project/program

OUTCOMES are short term or medium term effects

IMPACTS are long term effects which may take years to develop

Bennett's Hierarchy of Evidence is one example of a logical framework where inputs and activities create outputs that can lead to outcomes and impacts. Having INDICATORS for each level will help to establish a plausible link to explain any measured changes.

- Inputs
- Activities
- Participation (OUTPUTS)
- Reactions of participants (short term OUTCOMES)
- Changes in participant Knowledge/Attitudes/Skills/Aspirations (short term OUTCOMES)
- Changes in participant Behaviors or Adoption of new practices (medium term OUTCOMES)
- End results (long term IMPACTS)

Objectives can be written in reference to any of the 7 levels of Bennett's Hierarchy. A complex objective will include indicators that are related to two or more levels. In the case of this e-learning program, we want to determine the short terms outcomes (changes in interest, knowledge, skill and/or experience level) of our participants.

Example

If PEF offers this ToT program to 100 participants, our first target could be to document the completion of the program by 75 persons in one year (indicator, target and timeline 1). Of these 75 participants, our next target is to document their increase in postharvest knowledge and skills by 20 to 30% compared to their initial level (indicator, target and timeline 2). Within one year, our target is for 80% of those who complete the training to offer a postharvest training program to an audience of 30 persons in their community (indicator, target and timeline 3).
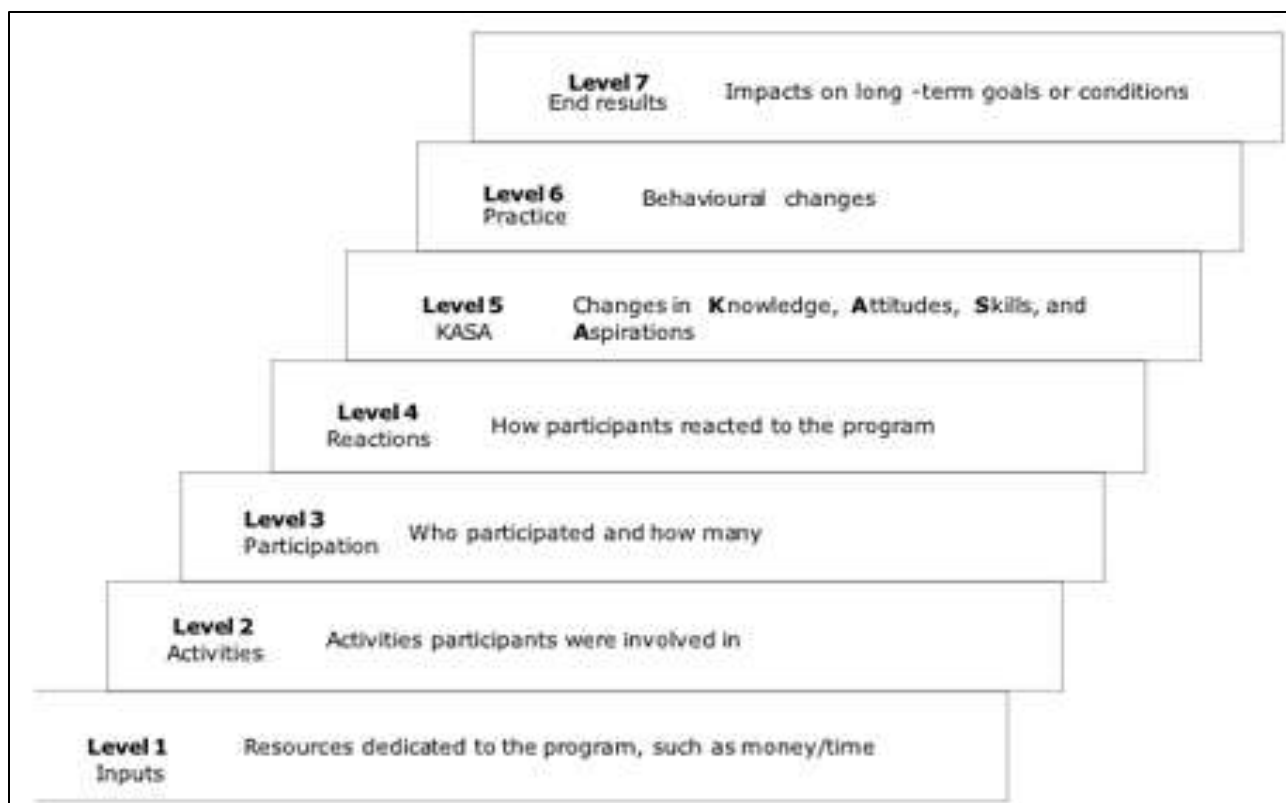
The 7 Levels of Bennett's Hierarchy of Evidence (Source: Bennett, C. (1975) Up the Hierarchy. Journal of Extension, 13(2), pp. 7-12.)

Evaluation Design: what is the overall plan for making comparisons?

There are several types of designs used to plan evaluations.

- Experimental (requires random selection and assignment, large sample sizes, so is usually not possible to achieve)
- Quasi-experimental (may be possible if you have a lot of time and funding)
- Comparison to a Baseline (if the indicators are expected to change over time)
- Comparison to a control group (if the program participants will show changes that are more or different than those of a similar group that did not participate)

Types of data and typical data collection methods

- **Quantitative** data (statistics, counts, numbers, costs, etc.) can be collected via making measurements, conducting formal surveys, analyzing secondary databases

- **Qualitative** data (on perceptions, beliefs, ideas, aspirations, behaviors, etc.) can be collected via observations, interviews, rapid rural appraisals, CSAM, focus groups

Assignment # 11

To plan an evaluation for a postharvest extension program we need to refer back to the Objectives that were written during the exercise in Chapter 9 on writing measurable objectives.

1) Select two of the Objectives and write them in the table below.

2) Describe **one INDICATOR and the LEVEL** of Bennett's hierarchy for each objective.

3) What is the **TARGET** and **Timeline** for each indicator?

4) What is the overall **evaluation design**? (Do you expect to measure a change in the indicator over some period of time? will you make a comparison of your participants to a baseline? or will you make a comparison to a control group?)

Objective	INDICATOR and LEVEL	TARGET and Timeline	Evaluation Design	Type(s) of data
1				
2				

5) Will the data be **quantitative or qualitative** or both? How will you collect the data? Provide at least one example.

Expected Outcomes and End Results of Assignment #11:

Participants will learn about the basic concepts of monitoring and evaluation for postharvest programs and projects.

Participants will gain experience with writing measurable objectives.

SELF-EXAM for Assignment #11

Date completed: _____

I was able to write the following measurable objective for my (imaginary or real) postharvest extension program: _____

The **indicator** that I will use to evaluate my objective is:

The **target** is:

The **timeline** is:

Do you believe your objective is **realistic and achievable**? YES _____ / NO _____

If you checked NO, please try to write a new objective and take the self-exam again.

ANNEX A: **Assignment 12**
Final Exam (Report 6) for the PEF ToT E-learning Program

Please download, complete and save these Annex A pages (the original blank document in MSWord can be found in your Google Drove folder).
https://drive.google.com/open?id=0B5xzz3hIIS3qczRBNmlZbkZNbUE

Complete your final exam (Part 1) and the TNA post-test (Part 2) in Annex A and compare it to your pre-test.

If desired, you may submit your completed Assignment 12 (Part 1 and 2) via email to PEF to receive a pdf of a signed Certificate of Completion (email: postharvest@postharvest.org)

Part 1
Your name: _____
Country: _____
Date: _____
Email address: _____

Key Assignments	Date completed	What did you learn that you think will be useful in your future studies or work? Why?
Self TNA pre-test (Report 1)		
Finding postharvest resources on the internet		
Commodity Systems Assessment (Report 2)		
Identifying appropriate technologies ad best practices		
Cost/benefit worksheet (Report 3)		
Designing a postharvest demonstration (Report 4)		
Designing a postharvest training program (Report 5)		
Final Exam and Self-TNA **post-test** (Report 6)		

Part 2

Post-test: Self TNA and program evaluation questions

Please complete the self-administered Training Needs Assessment form and submit it with the completed Final Exam table via email, along with any comments or suggestions you may have for improving future programs.

Postharvest Training Needs Assessment (TNA) Post-test Instrument

Full Name (exactly as you would like to see it printed on your certificate of completion)	
Job title (if any)	
Work Affiliation or University name	
Country	
Gender	Male _____ ; Female _____ ; Others _____
Email address	

Upon completion of the 12 Postharvest E-learning assignments in this manual, please rate yourself regarding your **current** level of **Interest**, level of **Knowledge**, level of related **Skills** and level of **Experience** in each of the categories or topics listed in the table below, on a scale where:

0 = none

1 = low

2 = moderate

3 = high

For example, you might rate yourself on:

	Interest	Knowledge	Skills	Experience
Teaching general postharvest technology topics:	3	2	1	1

In this example, your interest level is **high**, and your knowledge is **moderate**, but you rated yourself **low** on skills and experience.

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
General production information:				
Identifying sources of production information				
Obtaining production information on equipment/tools				
Obtaining technical documents/scientific studies on agricultural production				
Postharvest Technology (PHT) Information:				
Identifying sources of PHT information				
Obtaining PHT information on equipment/tools				
Obtaining PHT technical documents/reports on scientific studies				
Performing postharvest loss assessments				
Participating in team Commodity Systems Assessments (survey preparation and data collection)				
Identifying causes and sources of postharvest losses				
Performing cost/benefit analyses to assess PHTs				
Needs assessment and program development:				
Determining client training needs/concerns in postharvest technology				
Planning postharvest extension programs for farmers				
Designing training modules and course materials in postharvest technology				
Producing extension publications: Brochures				

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
Newsletters				
Trade magazine articles				
Extension manuals				
Promoting extension programs				
Evaluating extension programs				
Teamwork:				
Writing collaborative grant proposals for research projects				
Writing collaborative grant proposals for horticultural demonstration projects				
Establishing and strengthening linkages between growers/marketers/governmental agencies				
Communicating with colleagues in other countries by email				
Training/teaching:				
Teaching general production information/principles				
Providing training in market orientation for farmers				
Designing and implementing postharvest demonstrations				
Calibrating and maintaining postharvest tools				
Designing and using group training exercises				
Developing new audio/visual training aids such as:				
Posters				
PowerPoint presentations				

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
Videos				
Using modern equipment for quality assessment				
Developing short courses for industry				
Designing and managing study tours				
Implementing ToT programs				
Specific Agricultural Technology Topic Areas:				
Selecting planting materials				
Methods for season extension				
Harvesting methods and tools				
Maturity indices for fruits and vegetables				
Packinghouse operations/sorting, grading, cleaning, etc for fresh produce				
Packing methods				
Packaging materials				
Postharvest pest management				
Pre-cooling methods/temperature management				
Relative humidity management				
Cool Storage practices				
Refrigeration systems				
Quality control and inspection				
Transportation of produce (fresh, staple crops)				
Destination marketing (domestic)				
Export marketing				
GlobalGAP/food safety practices on farm				
Food processing methods (fresh, staple crops)				

Rate yourself on your level of:	Interest	Knowledge	Skills	Experience
HAACP/food safety practices for processing				
Managing a packinghouse or processing facility				
Marketing strategies for small scale farmers				
Determining costs and benefits of various postharvest technologies (i.e. packing, processing, storage, shipping methods)				

In particular we are interested in your honest opinions on these evaluation topics (check mark the YES or NO box for each):

Evaluation Questions	YES	NO
Was the length of the program acceptable?		
Were the costs (time, money) for you to participate acceptable?		
Was the program challenging for you?		
Did the 12 assignments hold your interest? (explain if yes or no, for example, did you look forward to the next assignment?)		
Were any of the assignments too difficult? [If yes, which ones?]		
Was any assignment **not needed?** [Please name the topic and explain, for example, if it **did not** help you to learn anything new.]		
Did you find the Postharvest E-learning program useful for your work or studies?		
Do you think a Postharvest Tool Kit would be useful for your work or studies? [If yes, why? And what tools would you use?]		
Would you recommend this PEF ToT manual and postharvest training program to others?		

Please feel free to provide any other comments or suggestions to help PEF to improve this ToT program and training manual:

Please download, complete and save these Annex A pages (the original blank document in MSWord can be found in your Google Drive folder:

https://drive.google.com/open?id=0B5xzz3hIIS3qczRBNmlZbkZNbUE) and then send us your Final Exam and TNA Post-test via email.

We will send you a signed **Certificate of Completion**.

****

CONGRATULATIONS on your completion of the PEF Postharvest ToT program!

Please share your status as a new e-learning graduate on our PEF networking pages.

FACEBOOK: http://www.facebook.com/PostharvestEducationFdn

LINKED IN: http://www.linkedin.com/groups/Postharvest-Training-3770124

If you know anyone who might like to donate to PEF to help us expand our postharvest education programs, please share this link: http://PayPal.Me/Postharvest

ANNEX B. Resources for Further Education and Networking

La Gra, J. 1990. **A Commodity System Assessment Methodology for Problem and Project Identification. Moscow, Idaho: Postharvest Institute for Perishables.**

Available online for free access.

English http://www.fao.org/wairdocs/x5405e/x5405e00.htm

Spanish http://www.fao.org/wairdocs/x5405s/x5405s00.htm

French http://www.fao.org/wairdocs/x5405f/x5405f00.htm

Hard copies of the 1990 CSAM manual (in English, French or Spanish) can be purchased from PEF for $25 each plus the cost of postage.   Please send an email to postharvest@postharvest.org to make your inquiry.

PEF LinkedIn.com Group

Link: http://www.linkedin.com/groups/Postharvest-Training-3770124

In this group of 6400+ worldwide members you will be able to interact with our PEF instructors and postharvest mentors. Members currently come from 150 different countries.

You will find discussions, you can ask questions, post links or comments and interact with many of the participants of current and past e-learning program.

University of California, Davis Postharvest Technology Center website:

http://postharvest.ucdavis.edu

Hosts a free to access online library of thousands of postharvest technology publications and references. You can find produce fact sheets, videos, posters and more.

Postharvest Tool Kits

The same postharvest tool kits that PEF provides for graduating e-learners in the Global postharvest e-learning program can be purchased from **Postharvest Tool Kits and Services** (current price is $350 plus shipping). For more information: http://www.postharvestinnovations.com/

ANNEX C: Videos
Postharvest video links for PEF short courses, workshops and training programs

PostharvestOrg on YouTube (PEF's channel)

https://www.youtube.com/channel/UCgPycz8ZVEwj4vWgaZyIgig

Overview

An Overview of Postharvest Loss of Cereals, Fruits, and Vegetables in Bangladesh

by PHL Institute (55 min)

https://www.youtube.com/watch?v=fqZ-HVTYAAw

Small-scale postharvest handling practices horticultural crops Part 1 (slide set with audio)

(9 minutes) by UCDpostharvest Harvest, curing, packinghouse operations

http://www.youtube.com/watch?v=i2GQJx99yU4

Small-scale postharvest handling practices horticultural crops Part 2

(10 min) by ucdpostharvest https://www.youtube.com/watch?v=2dfSwLYRYZs

Small-scale postharvest handling practices horticultural crops Part 3

(6 min) by ucdpostharvest https://www.youtube.com/watch?v=pgWPnLo9yP4

Solving postharvest losses in Africa (Rockefeller Foundation) 7 minutes

https://www.youtube.com/watch?v=ij_pBEGo-ng

To feed one billion more people (Rockefeller Foundation) 2 minutes

https://www.youtube.com/watch?v=8mF3Bq90Nuo

Waste not, want not: solutions for reducing postharvest loss.

University of Illinois workshop. 1 hour of presentations and discussion.

https://www.youtube.com/watch?v=ymwb1ygG1zY

UN FAO Food Wastage Footprint (4 min)

https://www.youtube.com/watch?v=Md3ddmtja6sandfeature=youtu.be

How Social Innovation Labs Are Tackling Post-Harvest Loss in Africa / Global Knowledge Initiative Collaboration Colloquium, Nairobi, Feb 2-14 (Rockefeller Foundation) 11 minutes

https://www.youtube.com/watch?v=wBphH1Ellh0

Post Harvest Technology [ENGLISH] National Science Foundation, Sri Lanka

https://www.youtube.com/watch?v=ML3ymcXLe80

Postharvest handling – farm level, harvest, maturity indices, shade after harvest, washing crates
Basic Practices: Postharvest Handling. Fintrac 8 minutes

http://www.youtube.com/watch?v=2UeMXb7dbykandindex=147andlist=PLkYdkQhqlqNx1zjh4TfybIbJDunUUyylp

Fiji farmers to benefit from postharvest research (Video 2) PARDI (Australia) 2:30 minutes

http://www.youtube.com/watch?v=Svtv2ZuFZ4Eandindex=150andlist=PLkYdkQhqlqNx1zjh4TfybIbJDunUUyylp

Postharvest handling series (Marita Cantwell)

https://www.youtube.com/watch?v=niYA0qrUJiE (Part 1)
https://www.youtube.com/watch?v=VIQhS2wP8Ho (Part 2)

The Post-harvest Professor by Ken Love
8 minute video featuring University of Hawaii Professor Robert Paull who talks about how to handle tropical fruits during harvest and post-harvest.

https://www.youtube.com/watch?v=FcYsTTSA2tI

Biological Control of postharvest diseases: Hurdles, Successes and Prospects
Speaker: Wojciech Janisiewicz, USA. Recorded live at the 2nd International Fruit Research Symposium 2012 in Leavenworth, Washington posted by e-Organic (22 min)

https://www.youtube.com/watch?v=_ZdxzMMGT2U

Inglorious Fruits and Vegetables (2 min)

This Supermarket Came Up With A Brilliant Way To Keep Food From Going To Waste

https://www.youtube.com/watch?v=qQQMygivn0g

Post Harvest Handling: Field Cooling

wiemerslagefarms   3 minutes

http://www.youtube.com/watch?v=KINFE1Zu2FAandlist=PLkYdkQhqlqNx1zjh4TfybIbJDunUUyylpandindex=78

Dole Bananas packinghouse operations in Costa Rica (manual harvest to packing) – large scale but all by hand to reduce damage.   5 minutes

https://www.youtube.com/embed/_l7sak6Vlq8?rel=0

Post Harvest Management of Fruits and Vegetables (A Case Study of SAFAL in India) Indira Gandhi Open University. 21 minutes (starts at 2 min point) includes a good overview of the ZECC

http://www.youtube.com/watch?v=95RRdoySdjAandlist=PLkYdkQhqlqNx1zjh4TfybIbJDunUUyylpandindex=68

Date harvest and postharvest handling (English) by Boudjebel VACPA (Packer and Exporter of Dates), Tunisia (2006)

Part 1 https://www.youtube.com/watch?v=bf9JXZlJP6wandfeature=youtu.beanda

Part 2 https://www.youtube.com/watch?v=Hn5XkPewAXk

Cooling/Cold rooms

Charcoal cool rooms: Keeping Crops Cool: fascinating field fridges in Africa

3 minutes Green Shoots   "it's practical, it's affordable, it's brilliant"

http://www.youtube.com/watch?v=ipqvedQW6a8

Kenya postharvest demonstrations by Jane Ambuko —ZECC and Charcoal cool room

https://www.youtube.com/watch?v=0dsjDNNpH5candindex=1andlist=LLVKt5897rdJZWvvTKSzZYiQ

Build your own Zero Energy Cool Chamber

12 min video (Swahili with English sub-titles) AVRDC by Roseline Marealle

https://www.youtube.com/watch?v=ZUUVI8isvxU

Coolbot Technology -- postharvest storage solutions | Jane Ambuko | TEDxNairobi

by TEDx Talks (18 min)

https://www.youtube.com/watch?v=z3qjxc4_fNA

Pack n Cool $4000 mobile cool trailer or $12000 small cold room with Forced Air cooler. (6 min)

North Carolina State University.

https://www.youtube.com/watch?v=gI4ieFRvB04

Forced air cooling (Jim Thompson)   4 minutes (Fresh-cut products workshop)

https://www.youtube.com/watch?v=0SfoIbclGUAandfeature=youtu.be

Solar powered cold room with battery back-up

SAHAR 4 minutes, views of the pieces and parts

https://www.youtube.com/watch?v=r2YP8uqcOpk

UCD videos

Cold Storage for Small Farms Part 1

https://www.youtube.com/watch?v=Pkwgz-jmmP0

Cold Storage for Small Farms Part 2

https://www.youtube.com/watch?v=73u6g5KSkuY

Storeitcold.com videos

http://storeitcold.com/installation.html (webpage with written instructions and video link)

http://www.youtube.com/watch?v=tTR6yfep8dM

Food processing

Jam and jelly making   3.5 minutes

https://www.youtube.com/watch?v=FLI7xRxqL_g

Boiling water canning, University of Maryland

http://afghanag.ucdavis.edu/other-topic/kitchen-gardens/kitchen-garden-vidoes/boiling-water-canning

Dried mango technologies in Burkina Faso (20 min) IRSAT

https://www.youtube.com/watch?feature=player_embeddedandv=WlY7gbHUv8g

RITECA II Project: Postharvest technology and fresh-cut sector. Value to fruits and vegetables by Riteca Proyecto Riteca (3 min)

https://www.youtube.com/watch?v=LZlD5lKGI1s

Solar drying

Drier designs - https://www.youtube.com/watch?v=SSF7jebz7gk

Maize drying in Kenya

https://www.youtube.com/watch?time_continue=256andv=BNJA_UxcaWA

Gari making process (Togo) small-scale equipment and labor steps via USAID

https://www.youtube.com/watch?feature=player_embeddedandv=XD_Mi24lr74

Some ideas of projects for reducing food losses and waste from FUSION

https://www.youtube.com/watch?v=U2er3zHxJic

Mobile phone based market access (Kenya) 5 min M-Farm
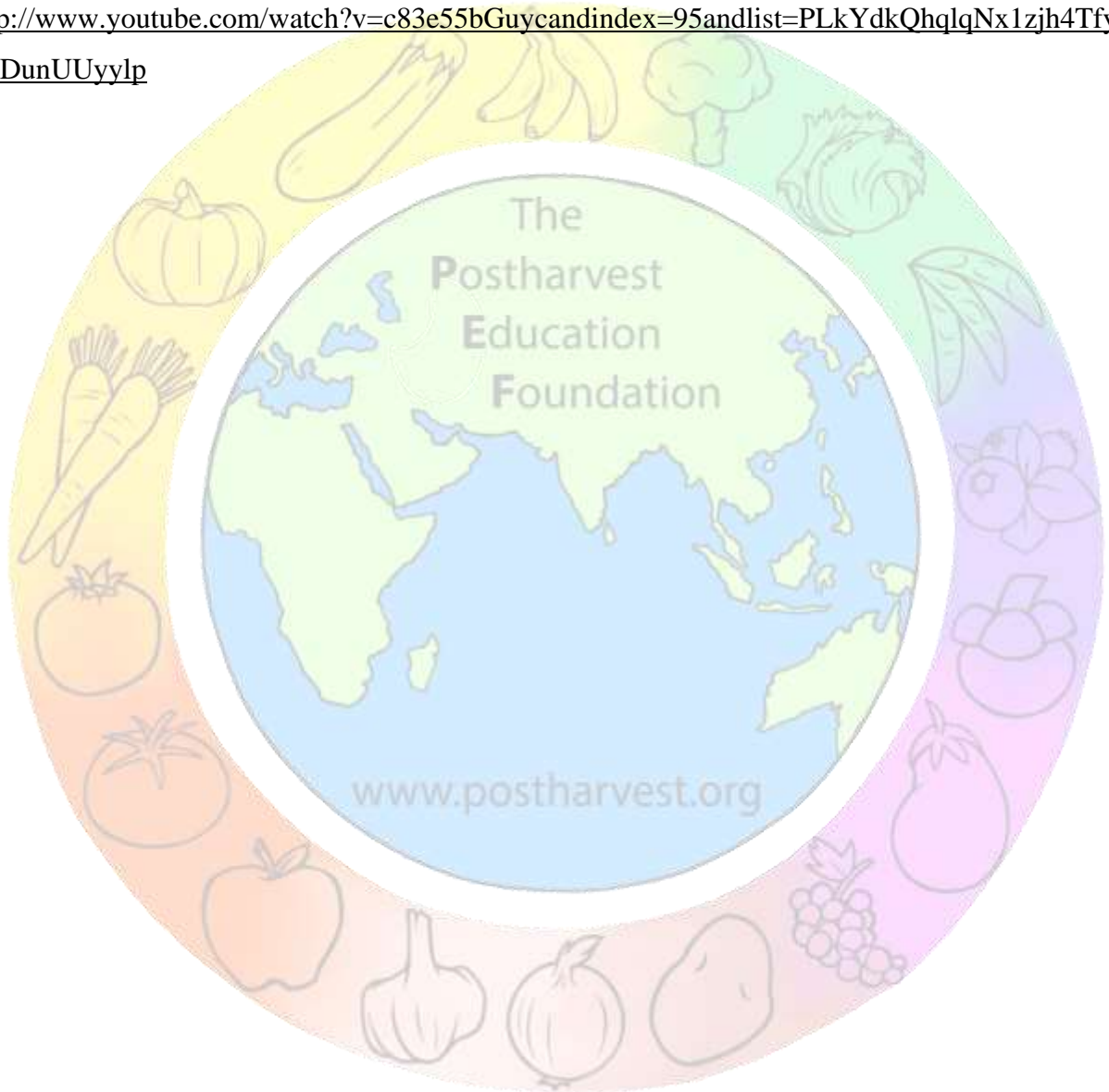
https://www.youtube.com/watch?v=GaUp759SjZY

Future Prospects in Postharvest Handling of Horticulture Crops

Mike Reid and Jim Thompson 32 minutes 2013

http://www.youtube.com/watch?v=c83e55bGuycandindex=95andlist=PLkYdkQhqlqNx1zjh4Tfyb
IbJDunUUyylp

ANNEX D
Agenda for a Closing Postharvest E-learning Workshop (Optional)

At the closing workshop for PEF programs, e-learning graduates receive their signed Certificate of Completion, Postharvest Tool Kit and gain practice in the use, calibration and maintenance of the tools. Lead instructors are welcome to model a closing workshop on the sample agenda of the PEF workshop that is provided below.

The Postharvest Education Foundation: Closing Workshop 2015 Global E-learning Program: Postharvest Technologies for Perishable Crops

Jimma, Ethiopia. 11-13 January 2016 – Three-day workshop to be offered by The Postharvest Education Foundation (PEF), Department of Horticulture, Jimma University and Sasakawa Africa Association on innovative postharvest technologies and educational / extension / training methods plus an introduction to M&E planning and practices for postharvest proposal writing.

Venue: 'JUCAVM AC HALL' (Near Department of Postharvest Management, Ground Floor)

Department of Postharvest Management, Jimma University, Ethiopia

Agenda DAY 1

Monday, 11 January	Topic	Lead instructor(s)
	Registration	
	Welcome/Orientation	
	Introductions	Dr. Ali Mohammed
	Postharvest programs and projects in Ethiopia -- Jimma University	Dr. Ali Mohammed
	The Postharvest Education Foundation -- e-learning programs and Postharvest Training and Services Centers (PTSCs)	Dr. Lisa Kitinoja
	Postharvest programs and projects in Ethiopia -- Samara University	Mr. Esa Abiso
	Lunch break	

	Postharvest demonstrations – introduction to postharvest innovations for cooling	Mr. Mekbib Seife Hilegebrile Kader Award Winner
	Site visits: - Horticulture and Postharvest laboratories - Pot in pot storages - Desert cooler storages	Dr. Ali Mohammed
	Temperature/relative humidity/packaging demonstrations	Dr. Lisa Kitinoja, Haile Tesfaye and Kemeru Umer
	Day 1 Questions and Answers	All instructors
	Demonstration design -- challenges and opportunities	All instructors

Agenda DAY 2

Tuesday, 12 January	Topic	Lead instructor
	Review Day 1 /brief QandA	
	PEF Global E-learning Program review	Dr. Lisa Kitinoja
	Presentation by PEF e-learners – CSAM	Hassen Yassin, Wollo University
	Presentation by PEF e-learners – cost/benefit analysis	Gezai Abera, Samara University
	Presentation by PEF e-learners – training program design	Sintayehu Musie, Debre Markos University
	Presentation by PEF e-learners - PTSC	Gerefa Sefu, Bahir Dar University
	Lunch break	
	Entrepreneurship in postharvest management	Dr. E. V. D. Sastry
	Site visit to Solar driers Coffee roaster Coffee husk Sheller Oil extractor Density separator (shaking)	Dr. Ali Mohammed
	Postharvest innovations for reducing food losses for roots/tubers	Aditya Parmar
	Group exercise – costs and benefits	Dr. Lisa Kitinoja and Dr. Ali Mohammed
	Day 1 Questions and Answers	All instructors, e-learning graduates
	Opportunities for Postharvest Networking LinkedIn.com SAVE FOOD Initiative	All instructors

Agenda DAY 3

Wednesday, 13 January	Topic	Lead instructor
	Review Day 2 / brief QandA	
	Postharvest tool kits	Dr. Lisa Kitinoja and past/present PEF e-learners
	Introduction to Monitoring and Evaluation planning and practices for postharvest programs and projects. Mission, Objectives, Indicators	Dr. Lisa Kitinoja
	Group exercise – writing measureable objectives	Dr. Lisa Kitinoja and Dr. E. V. D. Sastry
	Lunch break	
	Sasakawa Africa Association– Strategies for postharvest and agro-processing extension	Oumar Taha, Program officer
	Postharvest Technology – Global update on food loss reduction programs and initiatives	Dr. Lisa Kitinoja
	Day 3 Questions and Answers	All instructors
	PEF 2015 e-learning program graduation – award of tool kits and certificates of completion	PEF Board of Directors
	Closing address – award of certificates of participation	Dr. Ali Mohammed

Website: www.postharvest.org

Photos from a closing workshop demonstration in Uganda (2015)

Monitoring the postharvest demonstrations in Uganda and keeping records of quality changes, weight changes and temperature of fresh produce kept in the sun versus in the shade.

ANNEX E

Designing a Postharvest Training and Services Center (PTSC)

Assignment #13 (optional): Design a Postharvest Training Services Center (PTSC) for your own country.

Review the digital sketch of the PTSC and the sample reports for a site designed for Cape Verde (see pages 1-10) and Ghana for an understanding of the general idea. Each e-learner who has completed this training program has designed a PTSC for their own community. Some designs include a packinghouse, while others include a small farm to help generate revenue and provide fresh produce for training purposes. Budgets for a PTSC can be small, moderate or high, depending upon what is included and whether you need to purchase land to construct a building or are able to use a training venue that is already available/underutilized.

A recent article in the journal Agriculture provides an overview and findings from a project evaluation related to the development of the PTSC concept and model.

Resources:

Kitinoja and Barrett (2015) Extension of Small-Scale Postharvest Horticulture Technologies—A Model Training and Services Center. Agriculture 2015, 5, 441-455; doi:10.3390/agriculture5030441
PDF Version: http://www.mdpi.com/2077-0472/5/3/441/pdf

Visit the Hort CRSP website to read about the model PTSC in Arusha, Tanzania.
Hort CRSP Pilot Project -- Postharvest Training and Services Center
http://hortcrsp.ucdavis.edu/main/26pharvest_train.html (for a slide show on the project)

Acedo AL Jr, Rahman MA, Buntong B, Gautam DM. (2016). Establishing and managing smallholder vegetable packhouses to link farms and markets. Publication No. 16-801. AVRDC – The World Vegetable Center, Taiwan. 46 p.
http://203.64.245.61/fulltext_pdf/EB/2016-2020/eb0259.pdf

PEF E-learning program link: http://postharvest.org/postharvest_elearning_programs0.aspx

Give some thought to whether such a training center would be beneficial for your country or local community. Consider what you have learned in the PEF Postharvest E-learning ToT program about local training needs, the crops of interest, cost effective postharvest technologies or the benefits of making simple changes in handling practices.

If you decide to design a PTSC, use your imagination to think about possible locations, what type of equipment or tools you would need, who could be invited to conduct training or to support your training efforts. Consider what your ideas will cost, and if there are less expensive approaches, or options where you can combine efforts with an existing organization and share a training venue.

Optional Report for Assignment 13:

Title: Design for a PTSC for _____
(for example: a target crop, a farming village or your country)

In your report, include a title page, your name and country, and follow this outline.

Provide descriptions and specifications for:
1) Facility size and layout
2) Appropriate site (amount of land needed, sources of water, electricity, etc)
3) Target crops (one or more, why were they selected?)
4) Needed equipment and supplies for postharvest demonstrations
5) Proposed postharvest training activities (examples)
6) Goods and supplies to be offered for sale
7) Services to be provided for fees
8) Manpower needs
9) Estimated budget

In your budget, consider how much it will cost to construct the PTSC, outfit the PTSC with equipment/demos, and pay expenses for postharvest training programs and staff.

What kinds of income will be generated by sales or fees, so the PTSC can become financially self-sustaining?

A well written PTSC design report can serve as a first step to writing a grant proposal. International donor organizations and Ministries of Agriculture in many countries are currently looking for cost effective ways to address postharvest losses and to build capacity by training people on innovative handling methods, storage and processing technologies and marketing options that will lead to food loss reduction.

ANNEX F
Feedback examples for written reports (for lead instructors)

The MSWord version of this Annex is also included in the GoogleDrive folder "for lead instructors only". https://drive.google.com/open?id=0B5xzz3hIIS3qczRBNmlZbkZNbUE

General feedback would be "good" or "excellent" or "missing information" (refer to report outline)

Comments might mention that including a photo was helpful to better understand the problems identified for the crop, be used to praise a specific finding or to request more information or make a correction in a reported idea, a technical fact or a calculation.

Questions could include "what about_____?" or "what are your recommendations for _____?"

Commodity Systems Assessment (Report 2)

Name:

Email:

Country:

Crop:

Outline for a simplified CSA report

1) Title (including crop and country)

2) Your name as author (include your affiliation if desired)

3) Brief description of your methods and data sources (Did you make any field visits? Did you conduct interviews?)

4) Description of your findings for the 26 CSA components (Did you include any illustrations? Photos? Diagrams?)

5) Summary of the Research needs, Extension needs and Advocacy issues for the crop

6) Conclusions (what are the estimated % losses? what are the main causes and sources of losses?) and recommendations (what should be done?)

7) References

Topic	General Feedback	Comments and Questions
Methods/data sources		
Descriptions of the 26 components		
Research Needs		
Extension Needs		
Advocacy Issues		
Conclusions		
References		

Costs and Benefits (Report 3)

Name:

Email:

Country:

Crop:

Traditional/current practice or technology:

New/improved practice or technology:

Topic	General Feedback	Comments and Questions
Use of the C/B worksheet		
Relative costs of the improved practice		
Expected benefits of the improved practice		
ROI		

Postharvest Demonstration Design (Report 4)

Report Outline
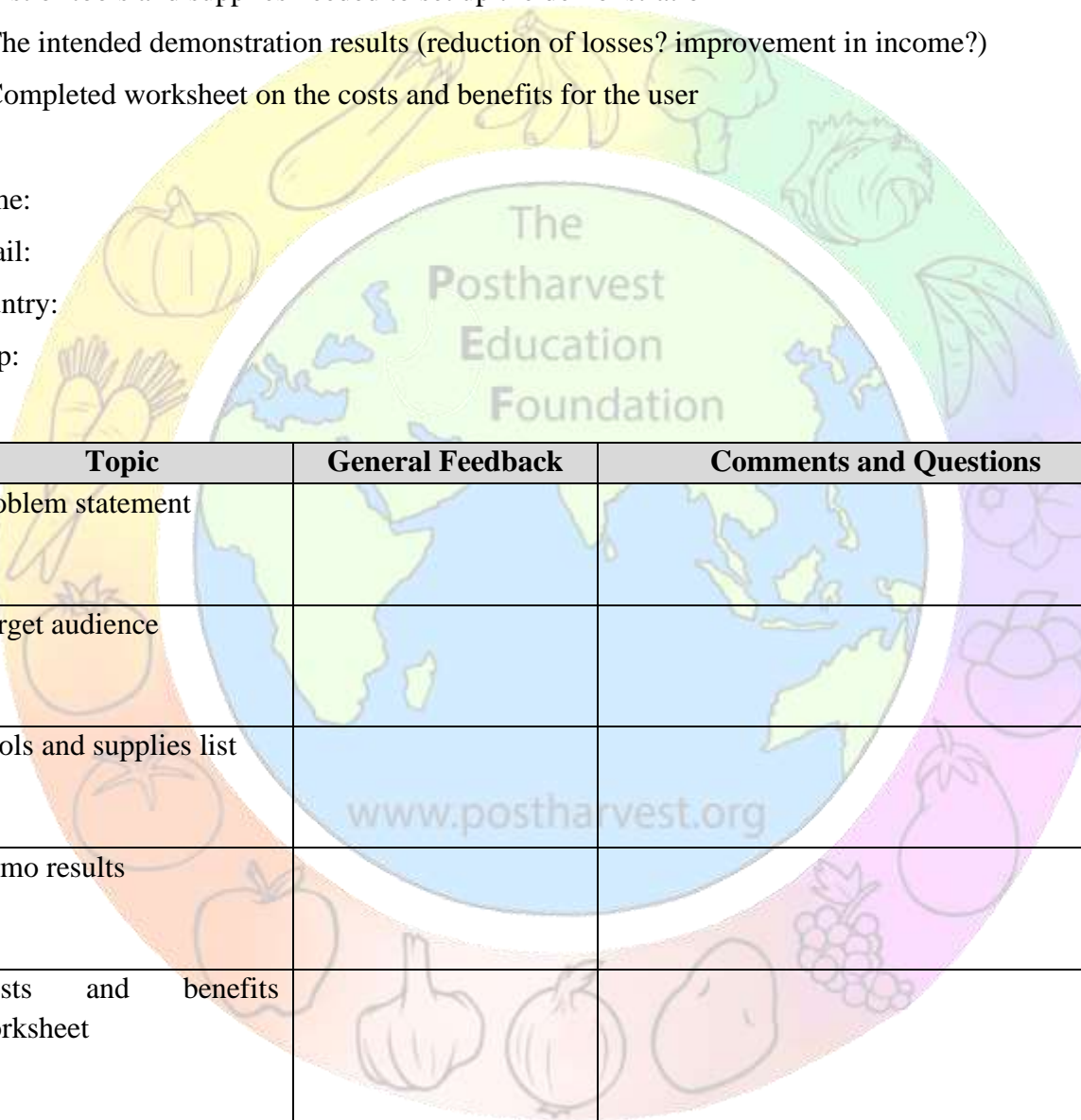
1) Brief statement of the problem that will be solved by the demonstration

2) Brief description of the target audience for your demonstration

3) List of tools and supplies needed to set up the demonstration

4) The intended demonstration results (reduction of losses? improvement in income?)

5) Completed worksheet on the costs and benefits for the user

Name:

Email:

Country:

Crop:

Topic	General Feedback	Comments and Questions
Problem statement		
Target audience		
Tools and supplies list		
Demo results		
Costs and benefits worksheet		

Postharvest Training Program Design (Report 5)

Report outline

1) Title of the training event

2) Your name and affiliation

3) Agenda (maximum of one day)

4) Learning Objective(s)

5) Audience (location, types and numbers)

6) Resources needed (number and type of instructors, training materials, tools, equipment, etc)

7) Outline of the training to be provided, with technical information, details on the demo(s) to be included, and a sample audio-visual training aid.

8) Costs and benefits of adopting the recommended postharvest technology or technologies -- use the C/B worksheet for each

9) Expected learning outcomes

10) Draft budget for the training program (what is the total cost, and what is the cost per trainee?)

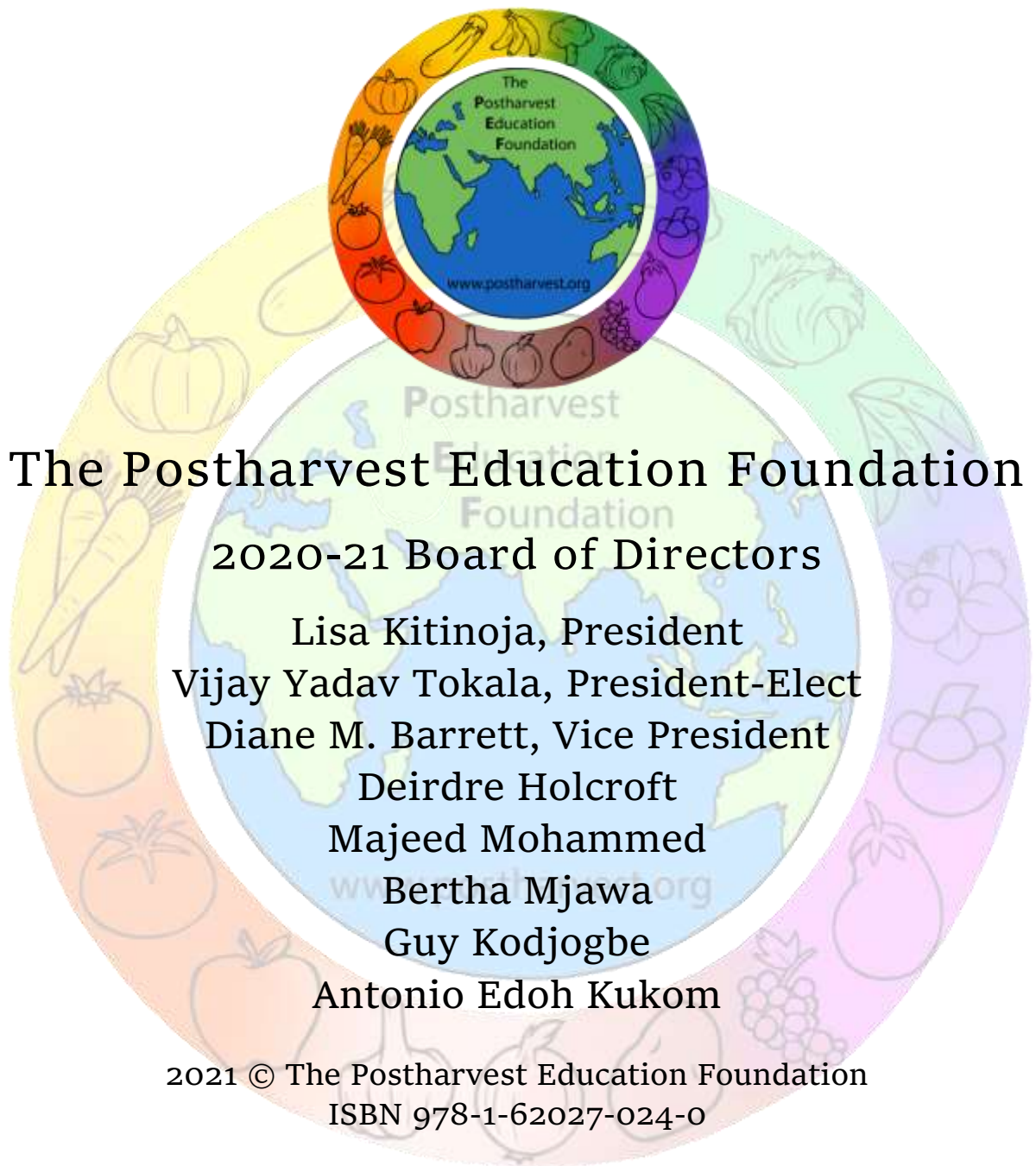Name:

Email:

Country:

Crop:

Topic	General Feedback	Comments and Questions
Agenda		
Learning objectives		
Target audience		
Resources needed		
Outline of training to be provided		
Costs and benefits		
Draft budget		

The Postharvest Education Foundation

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