Association of Nepalese Agricultural Professionals of Americas (NAPA) presents

NAPA Webinar Series: 19

Postharvest Management & Quality Regulations of Fresh Agricultural Produce in Nepal

Bed Prasad Khatiwada, PhD

Fresh Produce Safety and Quality Controller

Brisbane Markets, Brisbane, Australia

USA Time:
September 6, 2020
(Sunday)
8:00 PM CST

Nepal Time:
September 7, 2020
(Monday)
6:45 AM

Scan for **ZOOM** meeting

zoom 864 1610 5222

LIVE www.facebook.com/napa2072

Disclaimer and acknowledgement

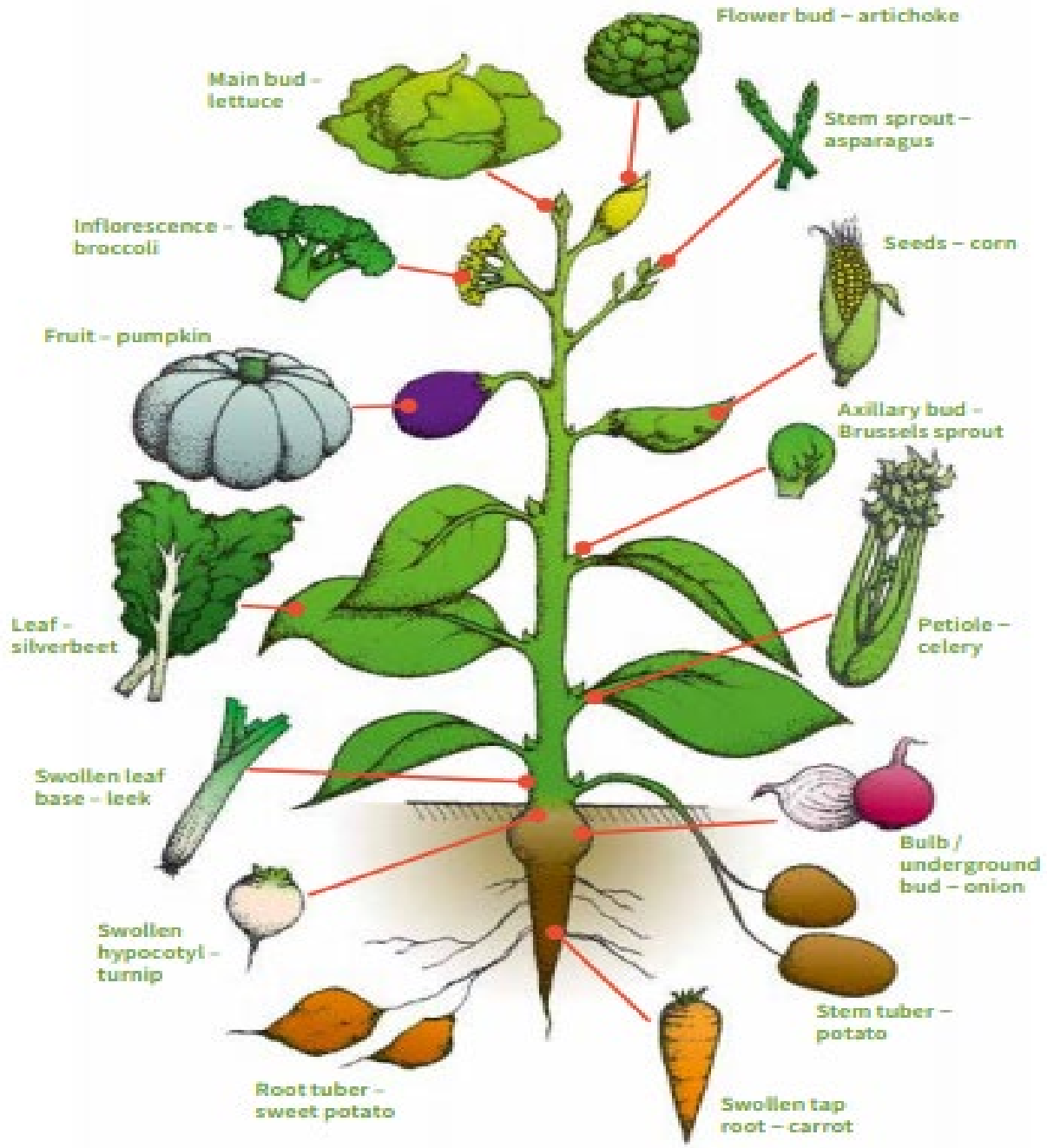
- Views shared are personal and based on my education, research and experience.
- Have no connection to institutions I am working/affiliated with.
- I acknowledge my Professor Dr. Durga Mani Gautam for seeding the postharvest research and Dr. Phul Subedi and Prof. Dr. Kerry Walsh (CQU, Australia), Prof. Beth Mitcham (UC Davis) for enriching the knowledge, particularly on Near Infrared Spectrosocpy (NIRS) for non-destructive assessment of fresh produce quality
- Thank You NAPA for providing this opportunity to share and learn from.

Postharvest Management and Quality Regulations of Fresh Agricultural Produce in Nepal

Bed P. Khatiwada, PhD

Outline

- Fundamentals
- Practices
- Economics
- Major Drivers
- Gaps
- Technologies
- Policy Environments
- Future Directions



Postharvest Management/Safety/Quality

- Interrelated/but different concepts
- Postharvest management refers to entire management after harvest (from harvest to consumption)

- Safety is related more to assurance that no harm happens due to consumption.
- Physical (glass, stones, dirt, hair), chemical (toxins, pesticides or sanitizers) and biological (bacteria, virus, parasites) agents.

- Quality is overall excellence and includes wide range of external and internal features (size, colour, TSS, TA, external/internal defects, flesh colour, flavour, nutritive value)
- Quality is the result of better postharvest management (process)

Nepalese Horticulture Sector

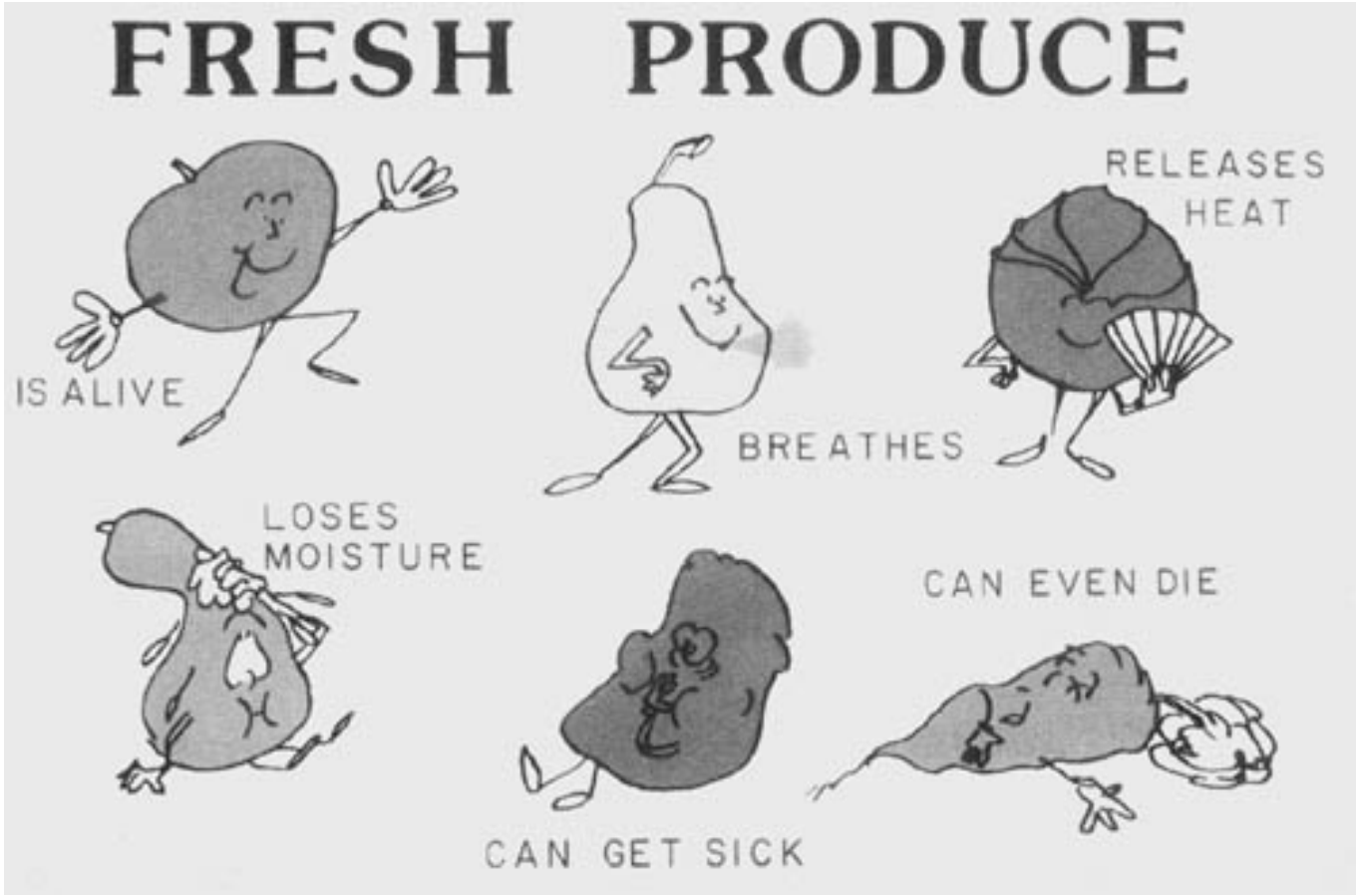
- Scale of operation
- Farmer's institutions (FGs, Agri Cooperatives and commodity based)
- Investments (a minimum mandatory investment policy)
- Market (Strategic location)
- Policy/Strategies (Favourable)
- Management/coordination/timely action

Fundamentals – The Facts

- Fresh agricultural produce are basically water in fancy packages
- Once detached from plant, entirely dependent upon management

- External factors
  - ❑Temperature
  - ❑Humidity
  - ❑Gases

- Internal (produce) Factors
  - ❑Transpiration
  - ❑Respiration
  - ❑Senescence

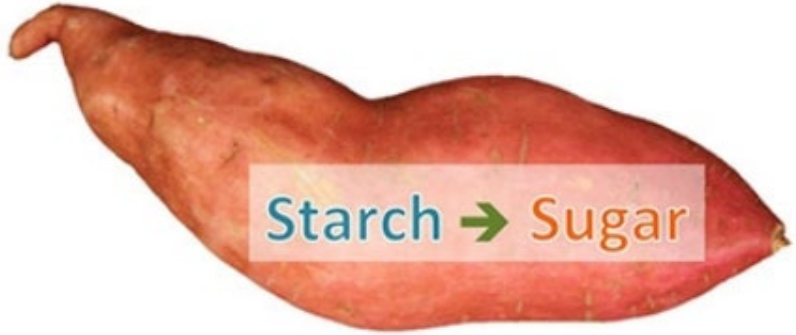


Temperature

- Temperature is the single **biggest factor** in postharvest quality
- Increased temperature - increased respiration - increased loss

- Low temp storage - starch converts into sugar - caramelization and loss in color/flavor (e.g., Potato/sweet potato)
- High temp storage – sugar converts to starch or used for respiration.

- Sweet corn - 24 hrs at 30^{o}C - lose up to 60 % sugar



Some Empirical Evidences

- Generally, for **each hour of delay** between harvest and cooling**, one day of shelf life** is lost.
- Produce left at **ambient, dry conditions** will lose moisture **up to 100 times** faster than produce that is moved into a cold room.
- Strawberry - each **one-hour delay** in cooling results in a **10% increase** in decay.
- 4-hour delay in cooling from 30°C, **about 70% marketable**, 8-hour delay in cooling, **only 40% of the** crop is marketable.
- Asparagus has a **five-day shelf life at 20**°C, compared **to 4 weeks when handled at 3°C**.
- Tomatoes left in the sun for one hour after harvest will be **at least 15°C hotter** than fruit held in the shade.

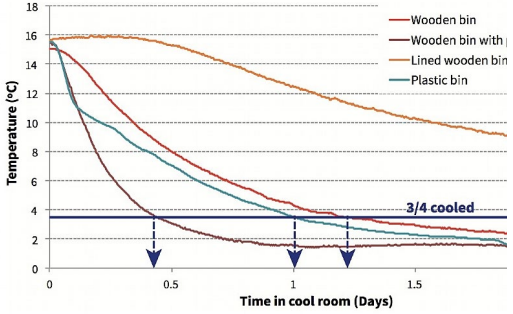
- Source: https://ucanr.edu/sites/Postharvest_Technology_Center_/files/230164.pdf)

Temperature Management

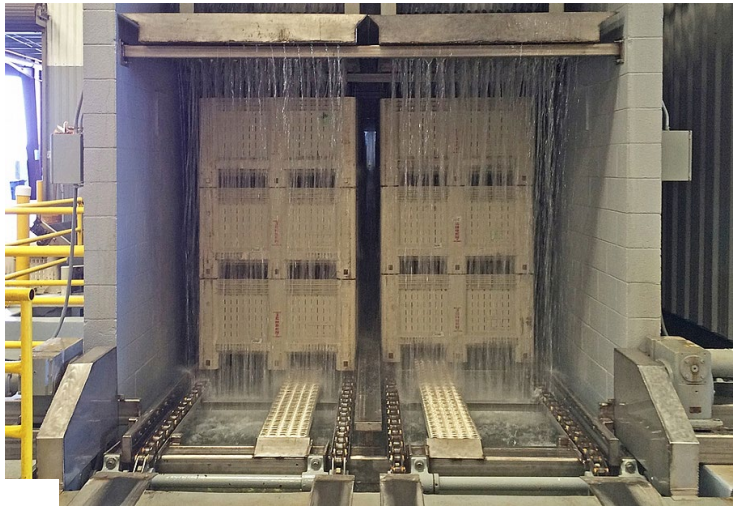
- Pre Cooling
  - ❑Removal of field heat which minimizes the deteriorative and senescence processes so as to maintain harvest quality that ensures customer satisfaction.
- Regulate temperature in storage or transportation and onwards

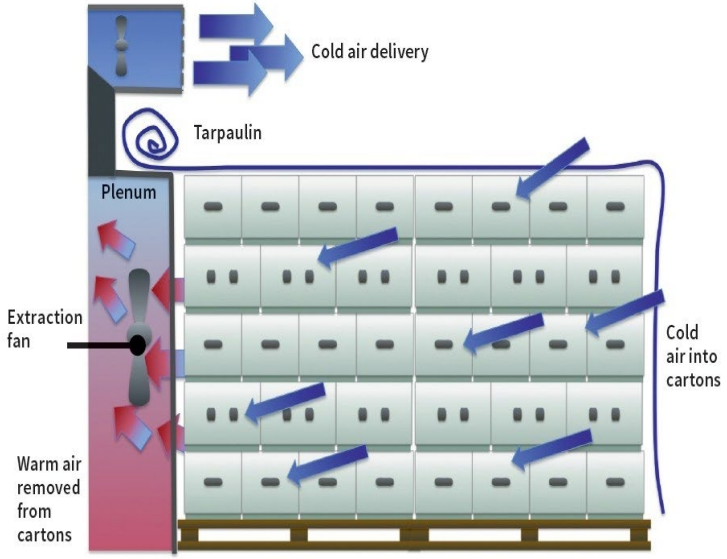
Temperature Management Methods

- Room Cooling



- Forced Air Cooling
  - ❑Apple
  - ❑Plum
  - ❑Pear, peach, oranges
  - ❑Most of the vegetables





- Hydro cooling
  - ❑Mango, radish
  - ❑Sweet corn, peach

- Ice cooling
  - ❑Broccoli
  - ❑Cabbage
  - ❑Carrot
  - ❑Radish, pea

Comparing Cooling Methods

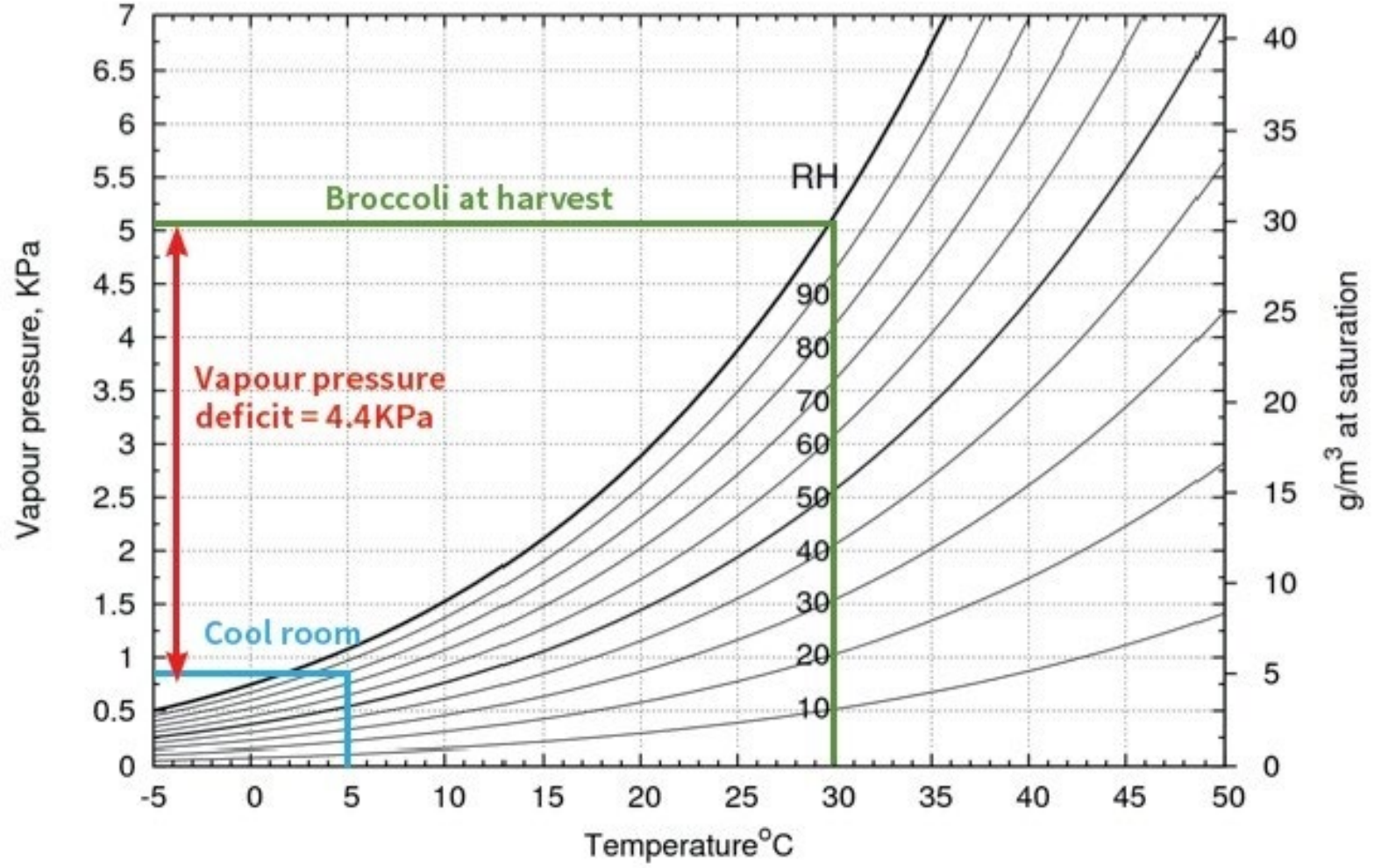
Table 2. Comparison of typical product effects and relative cost for six common cooling methods (modified from [2]).

	Room	Forced-air	Hydro	Electric evaporative	Passive evaporative	Package ice
Typical cooling time (h)	20–100	1–10	0.1–1.0	20–100	40–100	0.1–0.3
Produce moisture loss (%)	0.1–2.0	0.1–2.0	0–0.5	No data	No data	No data
Water contact with produce	No	No	Yes	No	No	Yes
Potential for decay contamination	Low	Low	High	Low	Low	Low
Capital cost	Low to medium	Low	Low	Low	Low	High
Energy efficiency	Low	Low	High	High	High	Low
Portability	No	Sometimes	Rare	No	Possible	Yes
Limitations and concerns			*	**	**	***

*Re-circulated hydro-cooler water must be constantly sanitised to minimise buildup of decay organisms
** Evaporative cooling to a few degrees above the ambient wet bulb temperature is possible
*** Melting ice can cause physical hazards during transport and unloading; packages need to be moisture proof and therefore tend to be expensive

Relative Humidity

- Important for leafy vegetables and other produce with little or no waxing or outer coatings



- Freshly harvested broccoli at 30°C if placed into a cool room running at 5°C and 80% RH - vapour pressure deficit is approximately 4.4KPa.

- If broccoli harvested at 10°C is placed into the same cool room, the vapour pressure deficit would only be around 0.7KPa (1.5KPa – 0.8KPa). Under these conditions moisture loss will be more than six times slower than in the first example.

Humidity

- Water loss of 3 to 6% is generally enough to cause a noticeable loss of quality and value.

- Stone fruits (peaches, plums and apricots) look shriveled when they suffer water loss of 4-5%.

- Root crops (carrots, beets, turnips, radishes) will lose water much faster if their tops are intact.

Effect of Humidity on Quality

- Wilting of leafy vegetable led to loss of vitamin C (Ezell and Wilcox, 1959).
- The loss of vitamin C in kale increases under slow wilting conditions from 0.05 to 0.11% h−1 under lower RH conditions.
- Reducing water loss not only reduces leaf yellowing, it increases sweetness and retards protein degradation and the loss of vitamin C in *Brassica juncea* (Lazan et al., 1987).
- 5% water loss in Capsicum leads to shriveling and affects quality.

Internal Factors – after harvest

- Transpiration
- Respiration
- Senescence

- Detached – No replenishment for any loss
- Structural integrity, internal metabolism differs

- Basic Physiology – Continues
- Stress Physiology- starts (e.g., ethylene)

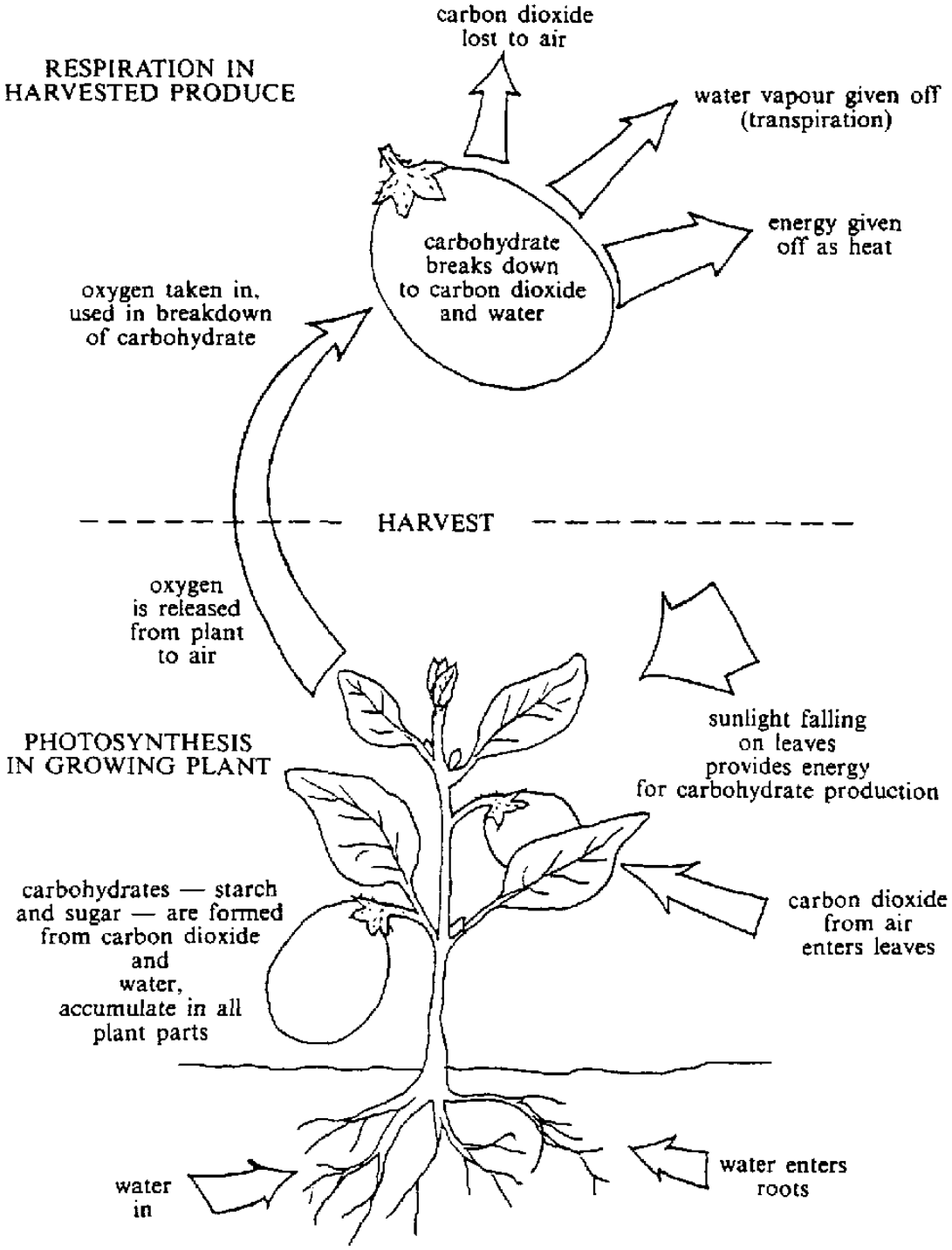
Transpiration / Respiration

Transpiration is a function of

- ❑Nature of skin
- ❑Coating of skin
- ❑Temperature
- ❑Relative Humidity

- Respiration is - process by which harvested produce starts consuming their glucose to survive.

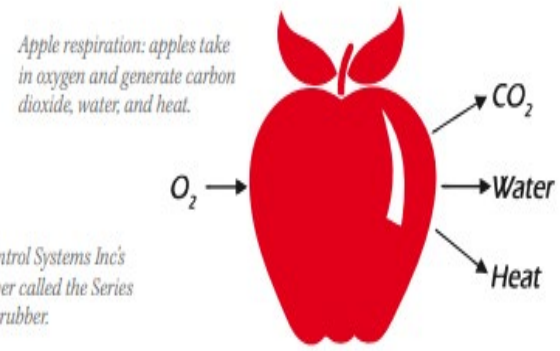
- Should be continued at a possible minimum rate without compromising quality.



Gases

- Manipulating the gas concentrations in the atmosphere around fresh products can maintain quality and extend storage life.
- Mainly Concentration of O_2, CO_2 (0.5 to 2.5%) and ethylene.
- High Oxygen leads to high respiration.
- High CO_2 lowers metabolism by slowing respiration and halts the ethylene production thereby improving quality

CA storage makes it possible to buy crisp, juicy apples year round.



Storage Control Systems Inc's CO_2 scrubber called the Series II Smart Scrubber.

Practices – Reality

- Crop Management – Nitrogen dominated rather than balanced- postharvest disorders blossom end rot and many others
- Harvesting practices – Micro and Macro wounds
  (Need feel, tools, benefits)
- Pre Cooling- Very low
- Packaging – use of crates/ boxes or rigid structures
- Size of package- unable to handle safely
- Packing house operations (sorting/grading/cleaning/packaging)
- Major Markets regulated by Government
  - ❑Storage
  - ❑Cool Chain

Postharvest Loss

- Loss in quality/quantity resulting decreased value
- Ranges from slight defects to total loss

नेपालमा फलफूलमा
१५ देखि ३० प्रतिशत र
तरकारीमा २० देखि ३५
प्रतिशत उत्पादनोपरान्त क्षति हुने
अनुमान गरिएको छ ।

Stages	Losses
Harvest	Injuries, pressure damage,
Packing process	Bruising, pressure damage
Storage	Chilling injury, decay
Loading/unloading	Injury, bruises, pressure damage
Transportation	Gas build up, pressure damage
Retails	Softening, decay, wilting
Consumers	Decay, wilting, softening, over mature

Effect of ripeness stage and drop height on incidence of internal bruising in tomatoes ('Solar set')

Drop height	Fruit with internal bruising (%)	
cm	Green stage	Breaker stage
0	0.0	0.0
10	5.0	73.0
20	5.0	100.0
30	45.0	100.0

Two drops on opposite sides. Extracted from SA Sargent at al. HS719 UF/IFAS, Fla. 2006

Research Facts

Table 1. *Effect of harvesting methods on PLW and decay loss in mandarin fruit in Cellar condition.*

Methods of harvesting	Days after storage											
	PLW (%)						Decay loss (%)					
	15	30	45	60	75	90	15	30	45	60	75	90
Hitting by stick	2.05	5.67	8.41	10.89	12.70	15.81	35.00	58.33	63.75	69.16	74.33	80.00
Direct pulling	1.58	2.41	3.73	4.84	6.75	8.82	13.33	36.50	50.00	58.33	65.00	66.66
Twisting and pulling	0.41	0.67	1.04	1.55	2.59	3.65	0.00	1.67	3.33	5.83	11.66	18.33
Clipping by scissor	0.17	0.34	1.00	1.33	1.90	3.15	0.00	0.83	1.67	2.50	5.00	8.33
Mean	1.05	2.27	3.54	4.65	5.99	7.86	12.88	24.33	29.68	33.96	39.00	43.33
LSD $_{0.05}$	1.02	1.76	1.90	2.11	2.41	2.38	9.26	11.82	13.76	12.86	16.03	21.07

Table 2. *Effect of harvesting methods on firmness and juice recovery in mandarin fruit in Cellar condition.*

Methods of harvesting	Days after storage											
	Firmness (kg/cm^2)						Juice recovery (%)					
	15	30	45	60	75	90	15	30	45	60	75	90
Hitting by stick	4.12	3.83	3.52	3.10	2.75	2.16	53.06	48.72	43.94	37.53	32.56	26.62
Direct pulling	4.15	3.85	3.60	3.30	2.95	2.38	52.98	50.69	48.30	46.52	44.83	42.74
Twisting and pulling	4.25	3.95	3.77	3.45	3.23	2.83	53.80	52.09	50.83	49.09	47.84	47.00
Clipping by scissor	4.25	4.10	3.95	3.75	3.58	3.30	53.38	53.08	52.56	51.99	50.85	49.69
Mean	4.19	3.93	3.71	3.40	3.13	2.67	53.31	51.15	48.91	46.28	44.02	41.51
LSD $_{0.05}$	NS	0.19	0.14	0.23	0.34	0.63	NS	NS	NS	8.85	8.52	8.88

NS: Non-significant

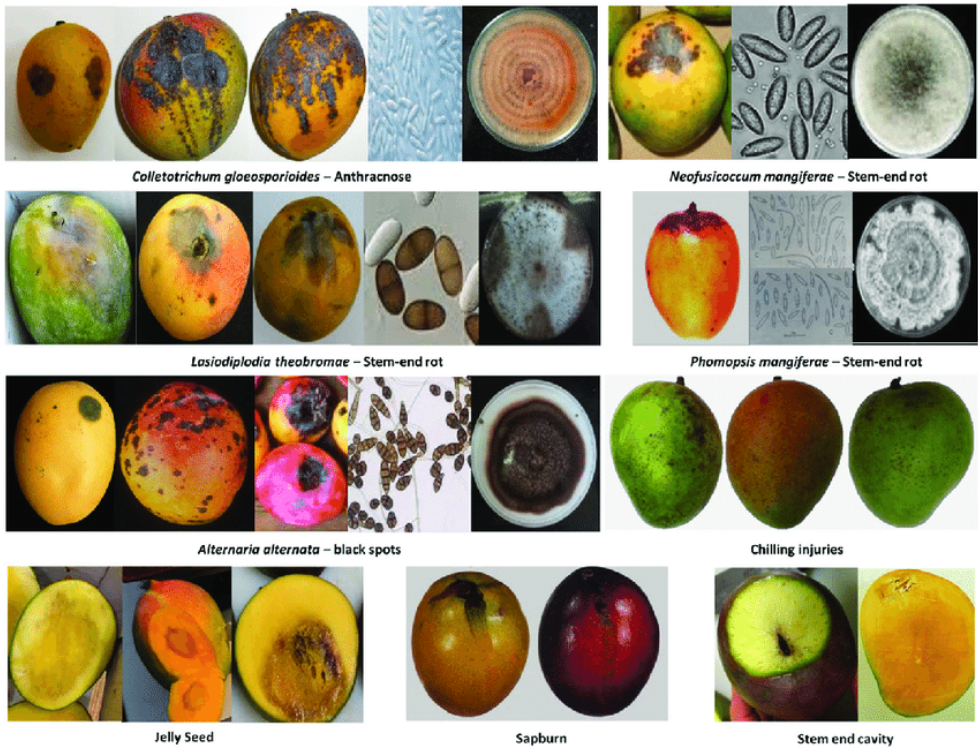
Pradeep Raj Rokaya, Dilli Ram Baral, Durga Mani Gautam, Arjun Kumar Shrestha, Krishna Prasad Paudyal. Effect of Harvesting Methods on Storage Behaviour of Mandarin (Citrus Reticulata Blanco) Under Cellar Condition. International Journal of Science and Qualitative Analysis. Vol. 6, No. 1, 2020, pp. 8-12. doi: 10.11648/j.ijsqa.20200601.12

Changes in Practices

- Implementation of Quality Assurance System (NepalG
  - ❑Particularly Food Safety and Product Quality Module
- Postharvest Operations
  - ❑Harvesting methods, maturity stage, treatments
  - ❑Temperature management
  - ❑Packinghouse operations
- Transportation
  - ❑Alternative arrangement for cold transport or at low temperatures (morning/night)
- Storage
  - ❑Cold rooms for HVP fitted with CoolBot while low cost technologies for others

Postharvest Disease management

- High temperature/high humidity is predisposing factors
- Combined with poor harvesting/sanitation process
- The optimum temperature for spore germination of most fungal pathogens is 20–25°C
- High RH and free moisture on produce both increase opportunities for disease development

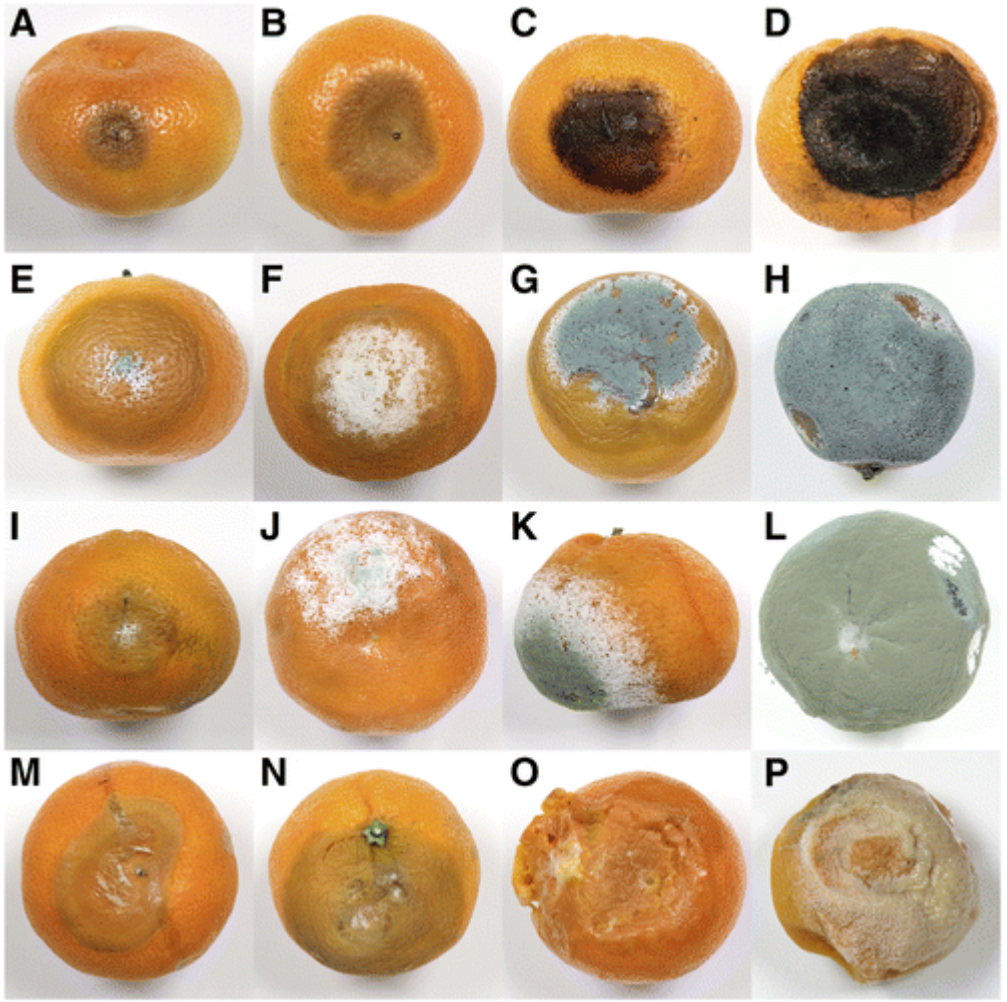


Wash with clean water/Proactive measures

- Temperature of the water
- High water temperatures can increase the effectiveness of washing. For example, short hot water rinsing and brushing treatments. Treatments typically range from 50 to 60°C and last for 10 to 30 seconds.
- Removes >99% of pathogens on the product surface.
- Vegetable structure—products with a smooth surface will be easier to clean than those with an irregular surface or complex structure, like cabbage.
- Presence and concentration of a sanitiser and pH of the water.
- Number of washes—multiple washes are more effective than one.
- Cleanliness of the water—large amount of organic matter then sanitiser will be ineffective and the washing process may deposit more microbes than it removes.
- Chlorine based compounds—calcium hypochlorite, sodium hypochlorite, bromo-chloro compounds, chlorine dioxide • Peroxyacetic acid • Iodine • Ozone

Table 3 – Overview of sanitisers suitable for fresh vegetables

Active ingredient	Sold as...	Monitoring	Key points
Calcium hypochlorite	Swimming pool chlorine Frexus dry chlorine briquettes, Ym-Fab Activ-8	Test strips Chlorine meters	Inexpensive and easy to use Some residual effects on pathogens Important to monitor and control pH (4.0 – 7.5) Quickly rendered ineffective if water is dirty Corrodes metals and packing equipment
Sodium hypochlorite	Household bleach		
Bromo chloro dimethyl hydrantoin (BCDMH)	Nylate®	Automatic analyser	Reasonably inexpensive Some residual effects on pathogens Less corrosive than hypochlorites Less affected by dirty water than hypochlorites Still effective at up to pH 8.5 Reacts to form both hypochlorous acid and hypobromous acid (2 x active ingredients) Must be generated on site
Chlorine dioxide	Vibrex hortiplus®	Redox probe	Effective at low concentrations Some residual effects on pathogens Not affected by dirty water Still effective at up to pH 8.5 Must be generated on site Relatively expensive Requires good ventilation for workers
Peroxyacetic acid (PAA)	Tsunami®	PAA test strips Automated analyser	Less affected by dirty water than hypochlorites Less affected by pH than hypochlorites By-products are biodegradable Effective at low temperature De-activated by high pH or high temperature
Iodine	AIS iodine granules	Automated analyser	Effective at broad pH range Not affected by dirty water



Recommendation for Postharvest Management: A Systems Approach

i. Production system
   - (GAP, GMP, NepalGAP, HACCP)

ii. Infrastructures and Facilities
   - (Roads, Packing house, Storage, Transport)

iii. Regulation and Action
   - Food standards update to include fresh produce
   - Product quality standard /Follow Codex

Major Drivers for Improved Management

1. Markets and Consumers
   - Open market economy
   - Price/quality determines consumer behaviour
   - Awareness for better quality
   - Intention to invest on quality/safe food

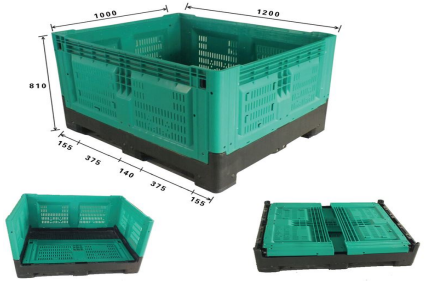
2. Regulatory Environments/Government's proactive position
   - Proactive government
   - WTO obligation to follow Codex Alimentarius as a food standard
   - Long term visioning on impacts of food safety/quality assurance

Economics

- Waste of all resources – used in production/preparation/transportation/handling and more.
- Value for improved practices – due to improved quality/long window
- Loss reduction – Increased availability - contribution to food security
- Multiple impacts
  - ❑Growth of allied industries – providing services to postharvest industry (tray/crate making, packaging materials, packing house machineries)
  - ❑Tourism
  - ❑Job creation

Gaps

- Technical know how- Technology is there, its reach to farmers is important thing
- Mechanisation to reduce drudgery
- Value for the improved management
- Availability of supporting aids/facilities/services
- Adoption Issues



Postharvest Technologies

Home Consumption – Freeze/Gamala Freeze

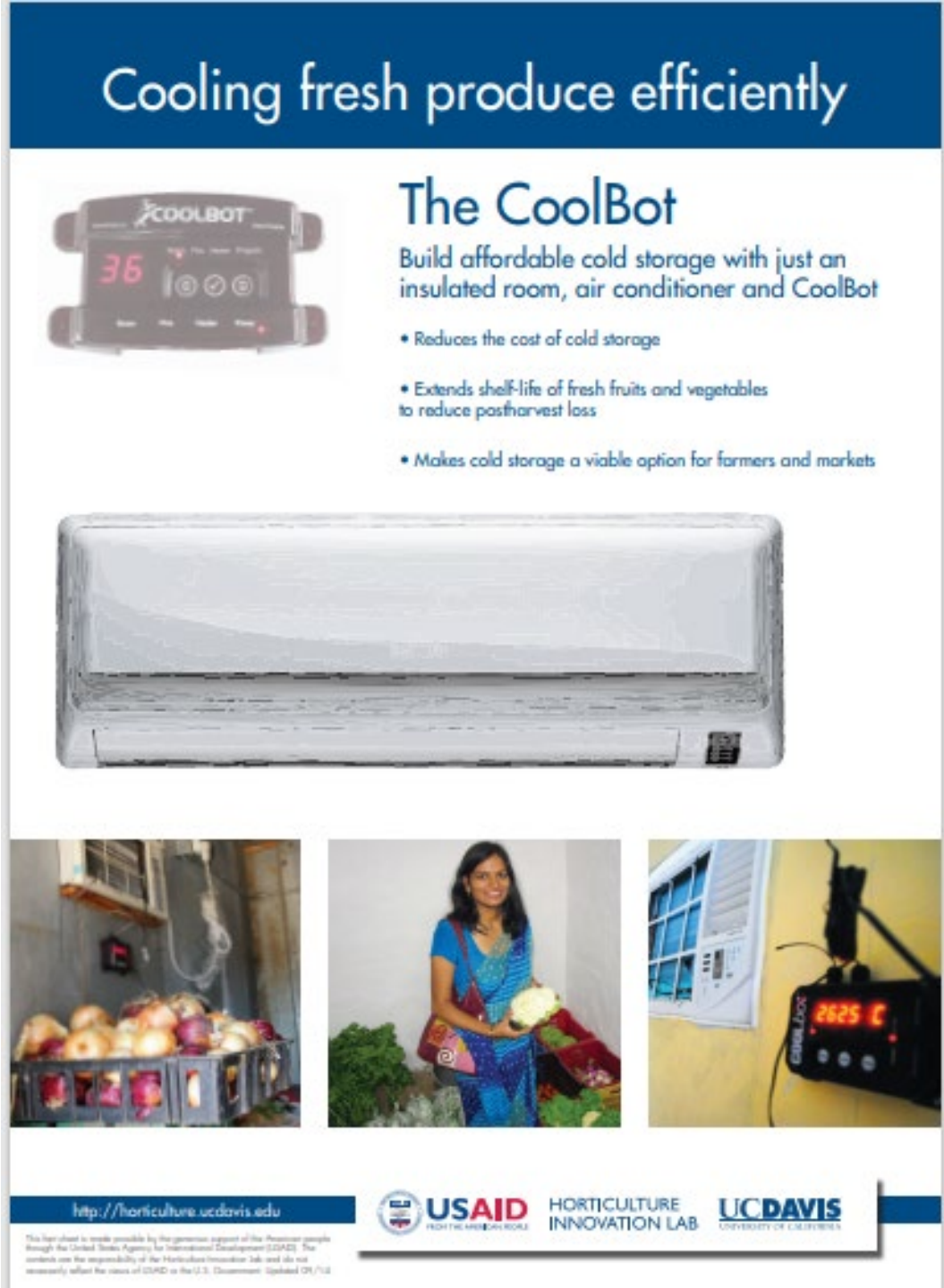
Small Farmers - Zero energy cool chamber

Collection Centers/ FGs/Cooperatives – ZECC or CoolBot

Agriculture Businesses- CoolBot or Room Cooling

CoolBot

- The CoolBot was developed by Store It Cold as an affordable way for small-scale farmers to cool fresh produce.
- This electronic device overrides an air conditioner's temperature gauge, tricking it into working harder while preventing components from freezing.
- With an air conditioner and a CoolBot, an insulated room can be converted into a cool room to store fresh produce before sale, to maintain quality and extend shelf life.



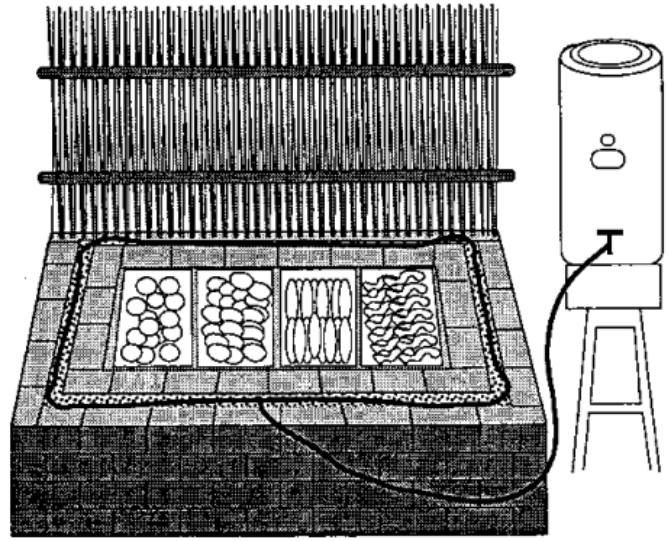
Zero Energy Cool Chamber

Table 10. Relative costs and benefits of investments in small-scale pre-cooling systems

Postharvest cooling technology	Location and crops for field tests	Initial cost including improved containers	Profit potential (additional profit compared to current practice of no pre-cooling)	Payback period at zero interest
ZECC 1MT size	India, tomato	$1,150	$140 / 1,000 kg	8.2 uses (8 weeks)
ZECC 1MT size	India, summer vegetables	$1,250	$390 / 1,000 kg	3.2 uses (about 3 weeks)
ZECC 100 kg size	India, summer vegetables	$125	$40 / 100 kg	3.1 uses (about 3 weeks)
CoolBot equipped cold room (6 MT)	India, potatoes stored for 3 months	$4,864	$1,296 / 6MT	1 year (4 uses)
CoolBot equipped cold room (6 MT)	Northern Ghana, onions stored for 4 months	$4,880	$8,790 / 6MT	Less than 1 year (2 uses)

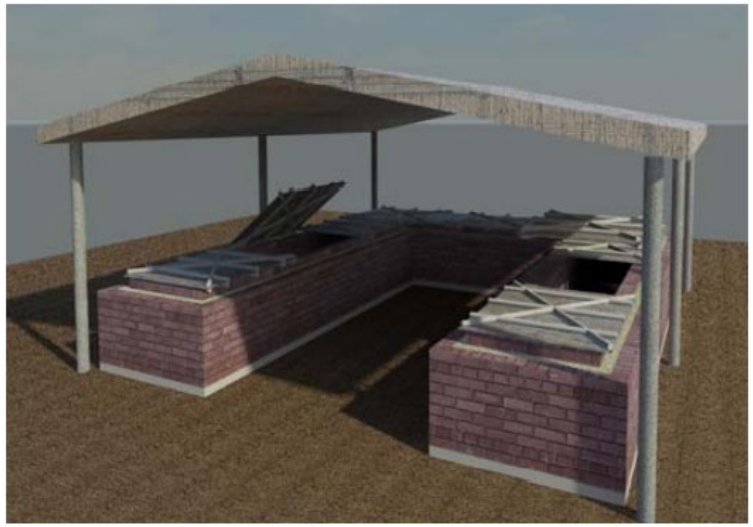
Source: Kitinoja [34].

Figure 5. Improved zero-energy cool chamber.



Source: Roy [10]; Illustration from [6].

Figure 6. The most recent design for the "walk-along" model of the ZECC was developed by SK Roy and colleagues at Amity University in India in 2009 [34, 35].



Farmers are practicing Sindhuli

सिन्धुली जिल्लामा जुनार उत्पादनोपरान्त/पोष्ट हार्भेष्ट, प्रशोधन र बजारिकरण सम्बन्धि कार्यहरु

- शीत भण्डार cold storage
- जुस उधोग juice factory
- संकलन केन्द्रहरु collection centers
- शुन्य शक्ति भण्डारण zero energy storage
- जुनार प्रशोधन लधु उधोगहरु junar processing small industries
- पोष्ट हार्भेष्ट सेन्टर post harvest centre

पोष्ट हार्भेष्ट व्यवस्थापनका लागि सहयोग औजार, उपकरण बितरण

लाङ्गघाली जुनार प्रशोधन उद्योग, गोलन्जोर ४, तिनकन्यालाई ५०% अनुदान उपलब्ध गराई जुनारको बिभिन्न परिकारहरु/प्रशोधित उत्पादनहरु जुस, स्क्वायस, जाम, जेली आदी प्याकिङ्ग गर्न बोतल र जरकिन खरिद, लेबल छपाई र औजार, सामाग्रीहरु व्यवस्थापन गरिएको।जुनार फल प्रशोधन र बजारिकरण सहयोग हुने।

सिन्धुली तीनकन्यास्थित शीत भण्डारमा राखिएको जुनार। तस्बिर : राजकुमार/कान्तिपुर

किसान लोकबहादुर आलेमगरका अनुसार पुस महिनामा भण्डारण गरिएको जुनार फागुन अन्तिम साताबाट बिक्री सुरु गरिएको छ। '३५ हजार दाना भण्डारण गरेका थियौं,' उनले भने, 'त्यो बिक्री गरेर दोब्बर आम्दानी भएको छ, तीन महिना भण्डार गरेपछि राम्रो मूल्य पाइएको छ।' सिजनमा ५० रुपैयाँ प्रतिकिलो बिक्री हुने जुनार अहिले भने भण्डारणस्थलबाटै

Ready to go, Syangja

Cleaning/grading/waxing facility, at Phaninarayan Aryal's packhouse

Policy Environments

- Agribusiness Promotion Policy 2063 BS
- Agriculture Development Strategy 2015-2035 AD

183. Component 3 of the ADS on Profitable Commercialization has an impact on food and nutrition security by (i) increasing income of farmers; (ii) improving access to markets; and (iii) reducing postharvest losses.

Food and nutrition security

Value Chain development Program

504. Differently from other value chain interventions in Nepal, the VADEP will have the following innovative features: (i) will be looking at and developing all the stages of the value chain, from seeds to final products, from production to processing, from market infrastructure to access roads and connectivity, from postharvest technology to quality assurance and exports; (ii) will strengthen linkages among associations of farmers, traders, processors, input providers and other value chain actors in order to ensure effective investment; (iii) will aim at replication and linkages beyond the district and achieve national impact; and (iv) will work not only with one district or department but across districts and departments.

- Government set good policy foundation for any programs or projects to support farmers through their institutions.

Food Safety/Quality Regulation

- Fresh agriculture produce should be viewed under broader food safety and quality framework.

- NepalGAP is a step forward for assurance of food safety and quality.

- Objective parameters/measurable

External/Internal features

बाली गुणस्तर मापदण्ड (Produce Quality Specifications)

बालीको नाम: काँक्रो

जात : भक्तपुर स्थानीय, ग्रेड: १

१	**सामान्य बाहिरी गुणहरु (General appearance criteria)**
रङ	घिउ रङको पृष्ठभूमिमा हल्का हरियो
बाहिरी आवरण	सर्लक्क परेको लामो, पुष्ट र सल्काइलो र मसिना काँडा परेको र कम्तिमा ५ मिमि भेट्नो सहितको, नरम बाहिरी आवरण, माटो वा विषादीको दाग वा अन्य कुनै धुलो नभएको, नच्याउरिएको
आकार प्रकार र तौल	२० देखि ३० सेमि लामो, ५ देखि १० सेमि व्यास, ३०० देखि ६०० ग्राम तौल भेट्नोदेखि पुछारसम्म क्रमश थोरै बढ्दो आकारको बेलनाकार, कतै सुकेको कतै फुकेको नभई सर्लक्क परेको
परिपक्वता	काटदा बीउ नछिप्पीएको, पहेंलो वा हल्का पहेंलो नभएको

countdown

Produce Specifications

PRODUCT : **Banana**
TYPE : **Ripe**
VARIETY : **Cavendish**
GRADE : **One**

GENERAL APPEARANCE CRITERIA				
COLOUR	With neutral colour at stage 3-4 for Summer; stage 4-5 for Winter; uniform colour within cartons.			
VISUAL APPEARANCE	With normal bright bloom.			
SENSORY	Firm, not soft; nil foreign smells or tastes.			
SHAPE	Slightly arched, with blunted butt end and intact, undamaged necks.			
SIZE	Prepack Diameter 35 – 45 mm 5 – 8 fingers per cluster Length 165 – 230mm Weight 850gm net per bag	Loose pack Diameter 35 – 45mm	Length 165 – 230mm	Clusters 4 – 8 fingers
MATURITY	Finger maturity thickness: measured at right angles to the curve of the fruit at a point one third from its flowering end.			
MAJOR DEFECTS				
INSECTS	With obvious live insects or other pests.			
DISEASES	With fungal diseases or soft rots eg. Anthracnose, black end rot, crown rot.			
PHYSICAL / PEST DAMAGE	With splits, holes, deep bruises or cuts through the peel into the pulp. With severed/broken necks.			
PHYSIOLOGICAL DISORDER	With excessive scattered brown spots/flecks (senescent spotting).			
TEMPERATURE INJURY	With dull, greyish, or blackened peel (chilling injury). With translucent pitting or blackening of skin, or translucent cores in the fruit (heat damage).			
MINOR DEFECTS				
PHYSICAL / PEST DAMAGE	With dry brown scab / speckling (insect damage), or with scars (bird damage) affecting areas >2 sq cm (per cluster) With reddish-brown blemishes (Banana rust) affecting areas >2 sq cm (per cluster). With dark sap stains affecting >4 sq cm (per cluster).			
SKIN MARKS / BLEMISHES	With superficial bruises (<1mm deep), abrasion or rub damage (tan/brown/black) affecting >4 sq cm (per cluster)			
PHYSIOLOGICAL DISORDERS	With reddish-brown discolouration >4 sq cm (maturity bronzing) (per cluster).			
CONSIGNMENT CRITERIA				
TOLERANCE PER CONSIGNMENT	Total minor defects (within allowance limit) to be < 3 defects per item Total minor defects (outside allowance limit) must not exceed 10% of consignment. Total major defects must not exceed 2 % of consignment. Combined Total not to exceed 10%.			
PACKAGING & LABELLING	Packaging as per Progressive requirements. Country of origin to be identified. Labelling to identify grower or agents name/brand (plus growers name/code if via an agent), address, contents, grade/class, size and minimum net weight. Bulk Loose Product to identify 'Packed On' date (eg. Pkd DD-MM-YY) on outer carton.			
RECEIVAL CONDITIONS	Stacked to TI HI specifications onto a stabilised pallet as pre-ordered. Refrigerated-ed van with air bag suspension, unless otherwise approved. Pulp Temperature 13 – 17 °C.			
CHEMICAL & CONTAMINANT RESIDUES	Imported and domestically produced food sold in New Zealand must comply with the New Zealand (MRL) Food Standard. The standard recognises the Tans-Tasman Mutual Recognition Agreement for food imported from Australia and the role of Codex standard for imported foods in general. Contaminants and heavy metals must comply with this standard.			
Specifications reviewable: eg, to account for specific regional effects or adverse seasonal impacts on quality or early or late seasonal variances as agreed with each state operation and communicated formally in writing by Progressive.				

Quality Assurance Programs

- Global GAP
- SQF
- Freshcare
- BRC
- HARPS
- NepalGAP

- These QA schemes are benchmarked with GFSI

- NepalGAP is developed in line with SAARC GAP and ensures safety and quality of produce

- Quality Standards /Codes can be different based on Food Businesses/ Individual firms / retailers

NepalGAP

नेपाल असल कृषि अभ्यासका मापदण्ड
(NepalGAP Standards)

नेपाल असल कृषि अभ्यासका मापदण्ड अन्तर्गत निम्नअनुसारका पाँचवटा मोड्युलहरू रहेका छन ।

क. खाद्य स्वच्छता मोड्युल
(Food Safety Module)

ख. पर्यावरण व्यवस्थापन मोड्युल
(Environment Management Module)

ग. उत्पादन गुणस्तर मोड्युल
(Product Quality Module)

घ. कामदारको स्वास्थ, सुरक्षा र हित मोड्युल
(Worker health, safety and welfare Module)

ङ. सामान्य आवश्यकता मोड्युल
(General Requirement Module)

Nepal GAP

- This is the most important development for safety and quality of produce
- All stakeholders should support to implement and extend its implementation
- We can start with high value, low volume crops for NepalGAP certification
- Examples include Asparagus, Kiwifruit, or so on.

Different Modules

खाद्य स्वच्छताको मोडयुलमा उत्पादन स्थल खेतबारीको इतिहास तथा यसको व्यवस्थापनका पक्षहरु, बिउ तथा बेर्ना जस्ता उत्पादनका वस्तुहरुको गुणस्तरका कागज तथा अभिलेखहरु, मल तथा माटोमा प्रयोग गरिएका रसायनहरु, सिँचाइ व्यवस्थापन तथा कृषि उपजहरु सफा गर्ने पानीको गुणस्तरको अवस्था लगायतका पक्षहरुलाई समेटछ ।

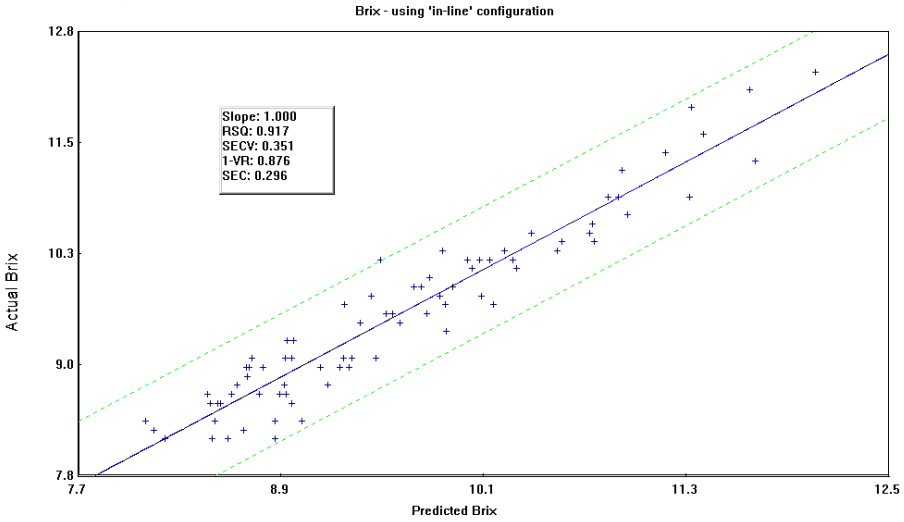
यसका साथै बाली संरक्षणका लागि प्रयोग गरिने उपायहरु, बाली उत्पादन लिने तथा त्यसपछिको बजारका लागि तयारी गर्ने अवस्था का साथै भण्डारण आदिको व्यवस्था पनि यसै मोडयुलले समेटछ । यस मोडयुलमा उत्पादनको अनुरेखता (traceability) तथा आवश्यकता परेमा फिर्ता गर्ने (product recall) सम्मको व्यवस्था गरेको छ । यसको मुख्य जोड कागजात तथा अभिलेखहरुको सुरक्षित अभिलेखीकरण तथा आवश्यक परेको समयमा तथा प्रमाणीकरण निकायले हेर्न खोजेको समयमा पाउन सकिने अनिवार्य व्यवस्था गरेको हुन्छ ।

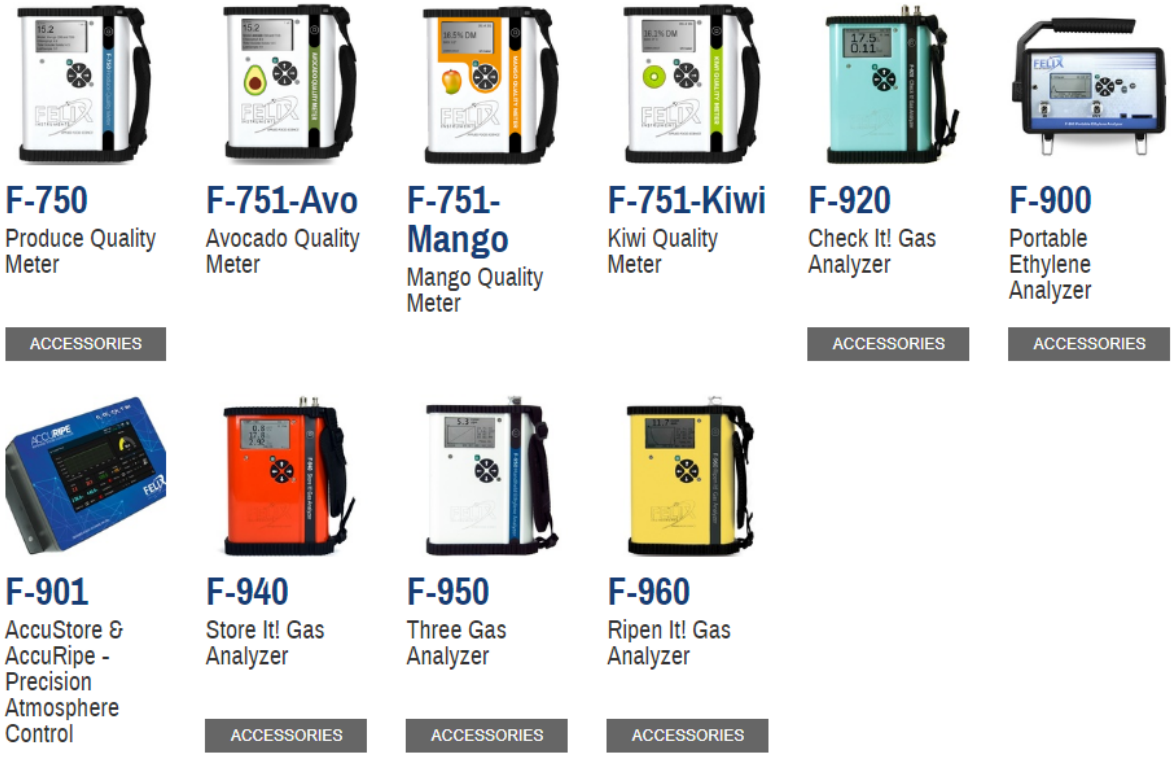
उत्पादन गुणस्तरको मोडयुलमा भने गुणस्तरको लागि योजना तयार गर्ने, बीउबेर्नाको गुणस्तर निश्चित गर्ने, रासायनिक मलका साथै स्थानीय रुपमा उपलब्ध माटोको गुणस्तर तथा उर्वराशक्ति बढाउने रसायनहरुको गुणस्तर सुनिश्चित गर्ने, सिँचाई तथा कृषि उपजको लागि धुन प्रयोग गरिने वा सबै प्रकारका पानीहरुको पिउने पानी सरहको गुणस्तर सुनिश्चित गर्ने, कृषि उपजको टिपाई, तथा भित्र्याउने क्रममा परिपक्वताको सुचक, टिप्ने समय, तथा उत्पादन टिप्न तथा राख्नका लागि प्रयोग गरिने उपकरण तथा यन्त्र एवं भाँडाकुँडाहरुको सरसफाई आदिमा ध्यान दिइन्छ ।

कृषि उपजको ओसारपसार, भण्डारण व्यवस्थापन तथा ढुवानीको क्रममा पनि आवश्यक तापक्रमको व्यवस्थापनमा पनि यस मोडयुलले समेटेको छ ।

Technologies for Quality – Monitoring, assessment and help making decisions

- Near Infrared spectroscopy (NIRS)
  - Optical methods based on light absorption and scattering (Assess DM, TSS, colors, defects)





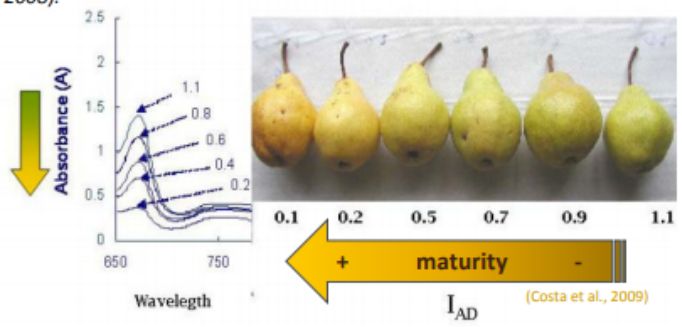
DA Meter

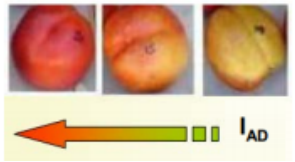
DA-meter… measures a new parameter called

Index of Absorbance Difference

$(I_{AD}) = A_{670nm} - A_{720nm}$

- Difference in absorbance between 2 precise wavelengths: 670 nm (near the Chl-a absorption peak) and 720 nm (background of the spectrum).
- I_{AD} is related to the **actual content of Chl-a in the fruit mesocarp** and to ethylene evolution during on-tree ripening *(Ziosi et al; 2008).*
- Is formed by 6 diode LEDs (3 diode emit at 670 nm and 3 at 720 nm) placed around the photodiode detector.
- Fruit is illuminated alternatively by the 2 monochromatic sources of light and the index represents the amount of light re-emitted by the fruit.
- Light detected by the photodiode is converted in a digital signal by ADC and a microcontroller provides the index.





WASHINGTON STATE UNIVERSITY

DA-meter…

….is FIRSTLY a RESEARCH TOOL, but can be largely used in any stage of fruit production and chain:

- ❑ by a grower to try to optimize the fruit distibution in the tree in order to have a more homogeneous product and reduce the number of picking stage;
- ❑ by the grower, to monitor the fruit growth and ripening in order, to identify the best moment to pick;
- ❑ by packing house, to pre-select fruits before store them and estimate the shelf life according to the ripening stage of different fruit boxes/groups;
- ❑ by the retailer to decide which riper fruit should be sold before others;

Moving forward

- Small farmers – organized through Farmers Groups/Cooperatives
  - ❑Technology/inputs in group
  - ❑Collection of marketable produce at collection centers
  - ❑Packing house operations at collection centers level
  - ❑Construction of small cold store with CoolBot
  - ❑Establishment of zero energy cool stores
- Commercial farms
  - ❑Better decision power
  - ❑Better investments
  - ❑Packhouse establishment
  - ❑Cold rooms with CoolBot

Start with few high value products

- High value low volume

  - ❑Asparagus
  - ❑Mushrooms
  - ❑Akabare Chilli
  - ❑Dragon Fruit
  - ❑Kiwi
  - ❑Avocado
  - ❑Off seasonal vegetables
  - ❑Apples /mandarin

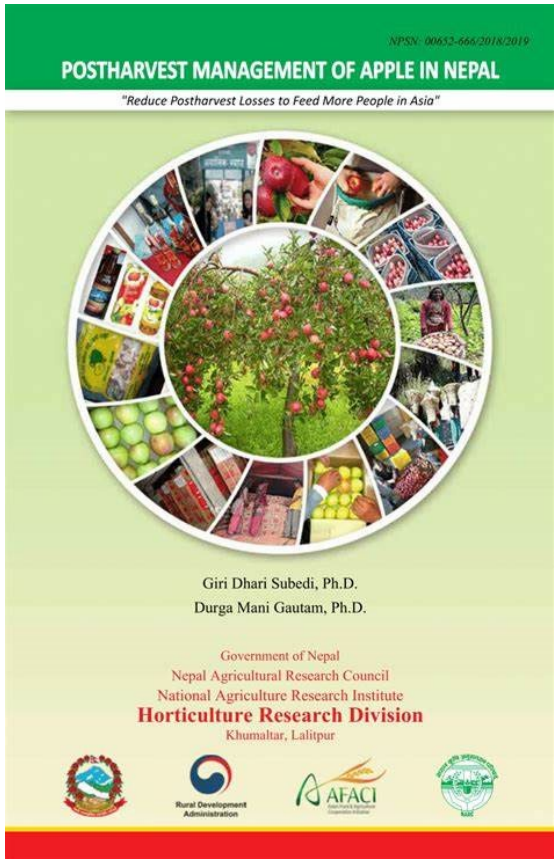
Future Directions

- Extending adoption of NepalGAP as a safety/quality scheme /postharvest management
- Development of safety and quality standards as per NepalGAP
- Decentralisation of support and services through local bodies
- Consultant services for commercial horticulture

Important Resources

- Agriculture Knowledge Centers
- Agriculture Information Center
- NARC and Commodity Research Programs
- IAAS, AFU, Thesis Research/Journals

- https://irrec.ifas.ufl.edu/postharvest/
- http://postharvest.ucdavis.edu/
- https://www.postharvest.net.au/
- http://www.fao.org/3/a1389e/a1389e00.htm



We are writing a book chapter

- Postharvest management and quality regulations for food safety and quality

- Bed P. Khatiwada, Shanta Karki, Purushottam P. Khatiwada, Kishor C. Dahal

- In a book to be published by NEPAFE (nepafe.org.au)

Thank You for your time

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- Binod Bhattarai, ED, Kalimati Fruit and Vegetable Market
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