Association of Nepalese Agricultural Professionals of Americas (NAPA) presents

NAPA Webinar Series: 19

Postharvest Management & Quality Regulations of Fresh Agricultural Produce in Nepal

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(Sunday)
8:00 PM CST

Nepal Time:
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(Monday)
6:45 AM

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Scan for ZOOM meeting
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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°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

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

- Hydro cooling
  - Mango, radish
  - Sweet corn, peach
### Comparing Cooling Methods

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

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

*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
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 in decreased value
- Ranges from slight defects to total loss

<table>
<thead>
<tr>
<th>Stages</th>
<th>Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest</td>
<td>Injuries, pressure damage,</td>
</tr>
<tr>
<td>Packing process</td>
<td>Bruising, pressure damage</td>
</tr>
<tr>
<td>Storage</td>
<td>Chilling injury, decay</td>
</tr>
<tr>
<td>Loading/unloading</td>
<td>Injury, bruises, pressure damage</td>
</tr>
<tr>
<td>Transportation</td>
<td>Gas build up, pressure damage</td>
</tr>
<tr>
<td>Retails</td>
<td>Softening, decay, wilting</td>
</tr>
<tr>
<td>Consumers</td>
<td>Decay, wilting, softening, over mature</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Drop height (cm)</th>
<th>Green stage (%)</th>
<th>Breaker stage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>10</td>
<td>5.0</td>
<td>73.0</td>
</tr>
<tr>
<td>20</td>
<td>5.0</td>
<td>100.0</td>
</tr>
<tr>
<td>30</td>
<td>45.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Two drops on opposite sides. Extracted from SA Sargent at al. HS719 UF/IFAS, Fla. 2006
### Table 1. Effect of harvesting methods on PLW and decay loss in mandarin fruit in Cellar condition.

<table>
<thead>
<tr>
<th>Methods of harvesting</th>
<th>Days after storage</th>
<th>PLW (%)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Decay loss (%)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitting by stick</td>
<td></td>
<td>2.05</td>
<td>5.67</td>
<td>8.41</td>
<td>10.89</td>
<td>12.70</td>
<td>15.81</td>
<td></td>
<td>35.00</td>
<td>58.33</td>
<td>63.75</td>
<td>69.16</td>
<td>74.33</td>
<td>80.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct pulling</td>
<td></td>
<td>1.58</td>
<td>2.41</td>
<td>3.73</td>
<td>4.84</td>
<td>6.75</td>
<td>8.82</td>
<td></td>
<td>13.33</td>
<td>36.50</td>
<td>50.00</td>
<td>58.33</td>
<td>65.00</td>
<td>66.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twisting and pulling</td>
<td></td>
<td>0.41</td>
<td>0.67</td>
<td>1.04</td>
<td>1.55</td>
<td>2.59</td>
<td>3.65</td>
<td></td>
<td>0.00</td>
<td>1.67</td>
<td>3.33</td>
<td>5.83</td>
<td>11.66</td>
<td>18.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clipping by scissor</td>
<td></td>
<td>0.17</td>
<td>0.34</td>
<td>1.00</td>
<td>1.33</td>
<td>1.90</td>
<td>3.15</td>
<td></td>
<td>0.00</td>
<td>0.83</td>
<td>1.67</td>
<td>2.50</td>
<td>5.00</td>
<td>8.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>1.05</td>
<td>2.27</td>
<td>3.54</td>
<td>4.65</td>
<td>5.99</td>
<td>7.86</td>
<td></td>
<td>12.88</td>
<td>24.33</td>
<td>29.68</td>
<td>33.96</td>
<td>39.00</td>
<td>43.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD&lt;sub&gt;0.05&lt;/sub&gt;</td>
<td></td>
<td>1.02</td>
<td>1.76</td>
<td>1.90</td>
<td>2.11</td>
<td>2.41</td>
<td>2.38</td>
<td></td>
<td>9.26</td>
<td>11.82</td>
<td>13.76</td>
<td>12.86</td>
<td>16.03</td>
<td>21.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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/cm²) |      |      |      |      |      |      | Juice recovery (%) |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------------------------|--------------------|-------------------|------|------|------|------|------|------|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 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<sub>0.05</sub>          |                    | NS                | 0.19 | 0.14 | 0.23 | 0.34 | 0.63 |      | NS               | NS    |NS    |NS    |8.85  |8.52  |
| NS: Non-significant         |                    |                   |      |      |      |      |      |      |                   |       |      |      |      |      |
Changes in Practices

• Implementation of Quality Assurance System (NepalGAP)
   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>
<thead>
<tr>
<th>Active ingredient</th>
<th>Sold as...</th>
<th>Monitoring</th>
<th>Key points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium hypochlorite</td>
<td>Swimming pool chlorine</td>
<td>Test strips, Chlorine meters</td>
<td>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</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>Household bleach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromo chloro dimethyl hydrantoin (BCDMH)</td>
<td>Nylate®</td>
<td>Automatic analyser</td>
<td>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</td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>Vibrex hortiplus®</td>
<td>Redox probe</td>
<td>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</td>
</tr>
<tr>
<td>Peroxyacetic acid (PAA)</td>
<td>Tsunami®</td>
<td>PAA test strips, Automated analyser</td>
<td>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</td>
</tr>
<tr>
<td>Iodine</td>
<td>AIS iodine granules</td>
<td>Automated analyser</td>
<td>Effective at broad pH range Not affected by dirty water</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Postharvest cooling technology</th>
<th>Location and crops for field tests</th>
<th>Initial cost including improved containers</th>
<th>Profit potential (additional profit compared to current practice of no pre-cooling)</th>
<th>Payback period at zero interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZECC 1MT size</td>
<td>India, tomato</td>
<td>$1,150</td>
<td>$140 / 1,000 kg</td>
<td>8.2 uses (8 weeks)</td>
</tr>
<tr>
<td>ZECC 1MT size</td>
<td>India, summer vegetables</td>
<td>$1,250</td>
<td>$390 / 1,000 kg</td>
<td>3.2 uses (about 3 weeks)</td>
</tr>
<tr>
<td>ZECC 100 kg size</td>
<td>India, summer vegetables</td>
<td>$125</td>
<td>$40 / 100 kg</td>
<td>3.1 uses (about 3 weeks)</td>
</tr>
<tr>
<td>CoolBot equipped cold room (6 MT)</td>
<td>India, potatoes stored for 3 months</td>
<td>$4,864</td>
<td>$1,296 / 6MT</td>
<td>1 year (4 uses)</td>
</tr>
<tr>
<td>CoolBot equipped cold room (6 MT)</td>
<td>Northern Ghana, onions stored for 4 months</td>
<td>$4,880</td>
<td>$8,790 / 6MT</td>
<td>Less than 1 year (2 uses)</td>
</tr>
</tbody>
</table>

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

Figure 5. Improved zero-energy cool chamber.

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].

Source: Kitinoja [34].
Farmers are practicing Sindhuli

Sindhuli Jilnamaa January Utapanoparannt / Post Harvest, Prashodhan Ram Jharikaran Samvadadhik Karyahan

- Sheet Bhagyad Cold Storage
- Juss Udyog Juice Factory
- Sankalan Kendrahra Collection Centers
- Shuniya Shikshita Bhagyadaran Zero Energy Storage
- Junar Prashodhan Lahdu Udhyogaran Junar Processing Small Industries
- Post Harvest Senhtar Post Harvest Centre
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

Food and nutrition security

**Value Chain development Program**

- 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
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
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 Nepal GAP certification
- Examples include Asparagus, Kiwifruit, or so on.
खाद्य स्वच्छताको मोडयुलमा उपयोग खालि खेतबारीको इतिहास तथा यसको व्यवस्थापनका पक्षहरु, बिजली तथा जलको जरारत उपयोगनका वस्तुहरुको गुणस्तरका कागज तथा अभिलेखहरु, मल तथा माटोमा प्रयोग गरिएका रसायनहरु, सिंचाई व्यवस्थापन तथा कृषि उपजहरु सफा गर्न पानीको गुणस्तरको अवस्था लम्बातका पक्षहरुलाई समेटेको ।

यसको साथै बाली संरक्षणका लागि प्रयोग गरिने उपायहरु, बाली उपयोग जिने तथा लसपछि जिन बजारका लागि तहाँ गर्ने अवस्था का साथै भण्डारण आदिको व्यवस्था पनि यसो मोडयुलले समेटेको ।

यस मोडयुलमा उपयोगनको अनुरक्षण (traceability) तथा आवश्यकता परेमा फिर्ता गर्न (product recall) समको व्यवस्था गरेको हुन । यसको मुख्य जोड कागजात तथा अभिलेखहरुको सुकर्षित अभिलेखकरण तथा आवश्यक परेको समयमा तथा प्रमाणीकरण निकायले देने खोजको समयमा पाउन सक्ने अनिवार्य व्यवस्था गरेको हुन ।

उपयोग गुणस्तरको मोडयुलमा भने गुणस्तरको लागि योजना तयार गरेन, बीचबेरीको गुणस्तर निश्चित गरेन, रासायनिक मलको साथै स्थानीय रुपमा उपलब्ध माटोको गुणस्तर तथा उर्वरायशक्ति बढाउने रसायनहरुको गुणस्तर सुनिश्चित गरेन, सिंचाई तथा कृषि उपजको लागि धुन प्रयोग गरिने वा सबै प्रकारका पानीहरुको पिघाने पानी तरहको गुणस्तर सुनिश्चित गरेन, कृषि उपजको टिपाई, तथा भिवाउने क्रममा परिपक्वताको सुचक, टिने समय, तथा उपयोग टिन तथा रासायनका लागि प्रयोग गरिने उपकरण तथा यन्त्र एवं भाँडारकृतहरुको सरस्फारी आदिमा ध्यान दिइँ ।

कृषि उपजको आवारणपर्सार, भण्डारण व्यवस्थापन तथा दुवानीको क्रममा पनि आवश्यक तापक्रमको व्यवस्थापनमा पनि यस मोडयुलले समेटेको हुन ।
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 Chi-a absorption peak) and 720 nm (background of the spectrum).
- $I_{AD}$ is related to the actual content of Chi-a in the fruit mesocarp and to ethylene evolution during on-tree ripening (Costa 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.

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 distribution 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 ripper 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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