

Summary:

Programme/ Procedure	Process/activity	Requirement or work instruction	Verifiable Indicator or supporting document
1. Supplier Management programme AA 1001	Agreement to supply	- Production of quality and safety produce - Maintain integrity after harvest, during handling and delivery	-Grower's statement -Packer's statement
	Information on purchased product specifications	- Planning and specify product requirements - Communication of requirements with suppliers - Review, change or up-date of specifications - Improvement	-Customer requirements -Import regulation/legislative requirements -Product standards/Specifications -Record of any change, review of specifications -Record/information of feedback/complaints
	Supplier classification	- Design and planning on supplier evaluation - Classification and monitoring of supplier - Effectiveness of the supplier evaluation	-Supplier Evaluation Form -Supplier classification -Supplier ID -Supporting document (farm notes) from the supplier -Record of supplier performance (consumer complaints)
	Supplier lists	- Maintain a summary list of suppliers	-Grower's supplier list -Packer's approved supplier list
	Trace Back or Traceability System	- Product identification and track back system on farm - Traceability on postharvest handling, packing and delivery	-Product identification including farm map, farm/block sign, field bins # -Farm operation and management record -Harvesting record -Packing record -Purchasing/inspection information and data -Packing line # -Package labeling and identification -Record of packinghouse operation including pack out record, delivery, and record of static quality trial
6.3 Control of safety hazards: Hygienic practice AA 1002 (H)	Establish hygienic/sanitation programme	- Management commitment - Establish appropriate hygienic programmes including: premise, pest control measure, personal hygienic and sanitation practice and training, - Avoid cross contamination - Sanitation programme	-Appoint sanitation officer-in-charge -Farm hygienic practice and sanitation programme -Packinghouse hygienic practice and sanitation programme -Check sheets
	Implementation and monitoring of hygiene/sanitation programme	- Appointment of sanitation officer-in-charge - Review of effectiveness	--Sanitation record sheet for monitoring -Model performance standards -Record of personnel training

		- Improvement	
6.4 Control of safety hazards: Chemical safety AA 1002 (C)	Pesticide policy	- Principles related to pesticide policy	-Statement of national pesticide policy -Statement of grower's pesticide practice
	Procedure for pesticide application	- Planning on pesticide usage - Pesticide application, method - Equipment - Review - Record of pesticide usage - Verification by residue testing	-List of agro-chemicals used -List of equipment, calibration, and maintenance -Pesticide usage log -Spraying record -Residue test report
	Establish pesticide residue levels	- MRL status and action required - Regulatory/legislative requirements	-Reference MRLs of the produce concerned -Material safety data sheet (MSDS)
	Agro-chemical usage	- Information of chemicals used on-farm - Characteristics/evaluation of pest risks	-Refer to Good Agricultural Practice (GAP)
	Management of pest risks	- Information of cultural and sanitation practice for managing pest	-Refer to GAP
	Risk assessment for pesticide residue	- Degree of risks on the use of prohibited chemicals - Risk and seriousness associated with exceeding residue levels	-Residue risk assessment programme -Priority for residue testing
	Sampling methods for residue analysis	- Sampling per farmer's plot - Primary sample weights - Minimum number of primary samples - Sampling required for a given non-compliance probability - Size of laboratory samples	-Sampling plan -Sampling record -Instruction on sampling size
	Pesticide residue analysis	- General precaution - Collection of samples - Sampling record - Preparation of the bulk sample - Laboratory requirements and methodologies - Record and reporting	-Instruction on sample collection -Instruction on sample preparation -Analytical methodologies -Laboratory records -Record of test results -Reporting procedure
	Communication of pesticide information	- Communication with importing countries - Handling of disputes	-Responsible authorities -Dispute handling process
3. Control of quality hazards AA 1003	Purchasing/inspection process and data	- Quality criteria of product concerned - Establish Acceptable Quality Level (AQL)	-Work instructions/graphs/drawing of quality criteria -Product specifications -Specified AQL and sampling plan

		- Purchasing and inspection process and work instruction - Qualified purchasing inspectors - Inspection and purchasing record	-Approved supplier list -List of purchasing inspectors and qualification -Supplier's farm record (as applicable) -Daily produce receiving record -Summary of inspection records
	Verification of purchased product	- Identify needs and site where verification take place - Acceptable quality levels and sampling plan for product verification	-Sampling plan -Verification record and report
	Establish critical quality parameters	- Identify and risk assessment of critical quality hazards	-Description of quality hazards
	Establish earliest maturity date and farm certification	- Application including statement of scope and intent - Desktop document review and decision on acceptance or deny of application - Sampling plan for verification of product - Product sampling procedures - Work instruction on product test requirements and methodologies - Laboratory requirements - Inspection report - Decision on certification - Product logo - Farm certification process - Appeals - Denying certification - Handling of disputes/appeal or non-conformities	-Application form -Result/report of desktop review -Lists of sampling officers -Sampling plan -Sampling record -Laboratory record of test -Record of product verification -Use of product logo -Applicant supplied information -Farm visit schedule and report -Farm certificates -Certification committee members, authority and responsibility -Record of certification decision meeting -Appeal form -Customer complaint record
	Mechanical damage assessment	- Assess the risk of mechanical damage and establish appropriate corrective/preventive control measures	-Check sheet on mechanical damage assessment
	Packing line postharvest operation	- Knowledge of produce characteristics - Design, analysis, and verify process flow - Review of process flow - Resources and facilities - Information and use of postharvest chemicals - Work instruction on chemical preparation	-Process flow -Packinghouse schematic diagram -List of equipment, calibration, record of maintenance -MSDS

	Postharvest treatment	- Access to information - Risk assessment - Work instruction on postharvest treatment and process control - Qualified staff and training	-List of key staff, qualification, and training record - Chemical usage log -Record sheets -Record of process control
	Labeling and packaging	- Package labeling requirements - Information on trend on package design - Package used - Future package improvement	-Specified label requirements -Access to package design information -Package specifications -Package information on the market place
	Loading into the container	- Container conditions and availability - Officer-in-charge of loading - Loading process and loading pattern - Container setting requirements regarding timing, temperature, ventilation, monitoring	-List of shipping agent -Shipping documents -Container checklists -Container settings -Loading record
	Temperature and humidity management during transport and shipping	- Knowledge of produce characteristics - Risk in temperature management	-Reference on produce characteristics -Produce transport requirements
	Static quality control and/or inland quality inspection	- Proper sampling size - Quality assessment - Management review	-Quality assessment report -Review and improvement record

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Annex 1

Hygienic Practice as Established by the Codex Committee on Food Hygiene

The Codex Committee on Food Hygiene on Hygienic Practice has issued a number of Codes. The framework used to establish standard code of hygienic practices for fresh fruit and vegetable is modified and simplified based on the Proposed Draft Code of Hygienic Practices for the Primary Production, Harvesting and Packaging of Fresh Fruits and Vegetables (Step 3 as of July 2000).

Grower	Packer
Code of Hygienic Practice include but not limited to the following • Personnel hygiene practice - protective clothing and foot wear - personal health and cleanliness - personal hygienic behaviour • Farm and facilities - farm location, design, and layout - irrigation facilities and drainage - toilet facilities and treatment system - facilities for farm waste management and disposal - other mobile facilities • Farm equipment - types and design of farm equipment/tools - material used and capacity - cleaning, maintenance, and storage of equipment • Hygienic farm practice - farm chemical application - use of manure and biofertilizer - domestic farm animals - use of sanitizing chemicals - farm chemical disposal - waste treatment/management • Hygienic harvesting practice - worker hygiene and hand washing - protective clothing against cross-contamination - harvesting tools and field container - on farm produce cleaning/washing and grading facilities - stocking/grading area - disposal of unacceptable produce • Water sources and usage of farm - water for human consumption - sources of water for irrigation (non-sludge) - water used for harvesting and washing produce - water used for sanitation purpose	Code of Hygienic Practice include but not limited to the following • Personnel hygiene practice - employee clothing and accessories - employee health, cleanliness and behaviour • Premises and facilities - location, design and layout - internal structure and fitting - toilet facilities and treatment system - facilities for packinghouse waste management, drainage and disposal - other mobile facilities • Equipment - types and design of packinghouse equipment/tool - material used - cleaning, maintenance, and storage of equipment • Hygienic packinghouse practice - postharvest chemical application - use of sanitizing chemicals - packinghouse pest control programme - waste disposal and treatment/management • Hygienic handling practice - worker hygiene and hand washing - protective clothing and auxiliary articles - packing line - treatment, grading and handling equipment - maintenance, cleaning programme - stocking area - storage area - disposal of cull • Water quality and usage in packing establishment - water for human consumption - water as ingredient - water in contact with produce - water used for sanitation purpose

Suggested Training for Various Sectors

Grower/harvester	Packer	Advisor/inspector	Entrepreneur
• Awareness and promotion of code of farm practice including the agricultural techniques and the agricultural inputs used • Harvesting method and judgment of harvest maturity • The probability of microbial, chemical and physical contamination • Internal auditing • Third party farm certification	• The nature of the fruit or vegetables and their handling and storage conditions • Fresh fruit and vegetable packaging • Complaint/product recall management system • Awareness and promotion of integrated chain management • Specific features of quality and options on quality management standards • Internal auditing and packing house certification	• Linking agricultural research, production process to pragmatic agricultural production and marketing • Introduction to general requirement of quality management and quality systems • Produce quality and value chain management • Farm or packinghouse inspection and certification	• Information management • Quality management of fresh horticultural produce • Quality system inspection and certification • Supply chain management

Annex 2

Guidelines for the Inspector on Hygienic Practice

(1) Auditing Guidelines

- 1 Applicant submit application for service and indicate scope of audit
- 2 The inspector prepare questions corresponding to the scope of the request as checklist and used as working paper
- 3 The inspector carry out desktop document review. The initial document review will include a detailed analysis of information submitted by the applicant such as farm note and farm care plan of the grower
- 4 Inform the applicant acceptance or reject of the application and including quote for service fees and term of payment
- 5 Conduct on-site inspection. On-site inspection will be of sufficient duration and detail. The inspector may write his descriptive report or using a prepared checklist. Check each question for either “pass” or “not pass”, or a ranking of “1 for non-compliance” as “2 for major”, “3 for minor”, “4 for observation” and “5 for compliance” or a score system of 5. Excellent performance, 4. Good active performance, above average 3. Some activities, average performance, improvement required in a set timeframe, 2. Below average performance, need to increase/improve activities, and 1. Little activities, require immediate improvement.
- 6 At the closing meeting after the inspection, recommend top priority corrective action to be taken
- 7 Undertake product verification when necessary. The samples could be assessed or sent to the laboratory
- 8 Data collection phase to establish a performance norms on “Hygienic practice”
- 9 Conduct and report subsequent follow-up inspection
- 10 Establish a new set of performance standard

(2) Suggested Grower Audit Working Paper and Example of Checklist on Farm Hygiene:

Part 1 Personnel hygiene practice

Requirements:

- protective clothing and foot wear
- personal health
- personal cleanliness and hygienic behaviour

Q: Are employees wearing protective clothing and foot wears during chemical application

Q: Are employees’ personal health acceptable, is there any provision of first aid for the employees

Q: Are employee personal hygienic behaviour acceptable

Part 2 Farm and facilities

Requirements:

- farm location, design, and layout
- irrigation facilities and drainage
- toilet facilities and treatment system
- facilities for farm waste management and disposal
- other mobile facilities

Q: Is there a farm note indicates farm location and farm map on design and layout includes water sources and drainage

Q: Past farm history, including environmental chemical contamination and flooding. The extend and seriousness

Q: Describe irrigation facilities and adequacy for the crop

- Q: Are clean toilets and hand wash facilities available and such facilities properly located
- Q: Is toilet treatment system likely to be a source of microbial contamination of the farmland that will lead to contamination of the produce
- Q: Describe kinds of farm wastes and methods of disposal. Are waste management and disposal methods acceptable?
- Q: Safety hazards that may be posed by mobile facilities?

Part 3 Farm equipment

Requirements:

- types and design of farm equipment/tools
- cleaning, maintenance, and storage of equipment

- Q: Examine the list of major farm equipment and descriptive function
- Q: Are the types and design of farm equipment/tool appropriate for the tasks to be performed and likelihood of cross-contamination during use
- Q: Is there a person responsible for cleaning and maintenance of farm equipment
- Q: Are their appropriate procedures established for cleaning and maintenance of equipment and are such practices considered acceptable
- Q: Is the storage area for the equipment acceptable

Part 4 Hygienic farm practice

Requirements:

- General farm hygienic condition
- farm chemical application (see example on guidelines for establishing information required in managing agro-chemicals)
- use of manure and biofertilizer
- domestic farm animals
- use of sanitizing chemicals
- farm chemical disposal and waste treatment/management

- Q: In hygienic conditions of the farm in general acceptable
- Q: Does the farm use any prohibited/banned chemicals and indicate the likely risk of such use
- Q: Is there any reference or record of result of pesticide residue analysis available
- Q: By examining the list of farm chemical application and withhold period describe in “Farm Care”, is MRLs likely to be a problem
- Q: Is the produce a high microbial risk as a result of the use of manure and biofertilizer
- Q: Is there any measure to exclude domestic farm animals especially during harvesting
- Q: Are the list of sanitizing chemicals provided and the use of such chemicals and practice acceptable

Part 5 Hygienic harvesting practice

Requirements:

- hand washing
- protective clothing against cross-contamination
- harvesting tools and field container
- on farm produce cleaning/washing and grading facilities
- stocking/grading area
- disposal of unacceptable produce

- Q: Do harvesters practice hand washing before harvesting
- Q: Do harvesters washing hand after visit to toilets
- Q: Are the harvesters provided with protective clothing in order to protect produce from microbial or chemical contamination
- Q: Likelihood of harvesting tools in causing microbial or chemical contamination

Q: Are field containers has smooth surface to reduce fruit damage
 Q: Are field containers cleaned to ensure free from chemical, microbial, and foreign material that may harm the produce and/or consumers health
 Q: Are harvesting tool and field containers stored in clean area
 Q: Does produce washing area on farm has amply supply of clean water,
 Q: Are on-farm produce-grading facilities adequate, in term of protection of harvested produce from microbial, chemical or physical hazards
 Q: Is the produce stocking/grading area in a clean and orderly condition
 Q: Is the procedure for the removal of fallen fruit and disposal of off-grade produce acceptable

Part 6 Water sources and usage

Requirements:

- water for human consumption
- source and quality of water for irrigation
- water used for harvesting and washing produce
- water used for sanitation purpose

There are many ways to format a checklist for self-assessment questions or third party audit in order to evaluate performance on the requirements of the procedure or process. The following shows an example on the recording of audit results on hygienic sanitation/ programme:

Requirement	Question No.	Actual performance observations	* Rating or Ranking	Action	Auditee signature
Part 1 Personnel hygienic practice					
protective clothing and foot wear	Are employees wearing protective clothing and foot wears during chemical application	No activities for this item	Not pass	Need to have a process on the item	
personal health	Are employees' personal health acceptable, is there any provision of first aid for the employees	Personal health good and verifiable first aid requirements	5	None required	
personal cleanliness and hygienic behaviour	Are employee personal hygienic behaviour acceptable	Toilet condition below average Lack hand washing practice	2	Increase activities required	
Part 2 Farm and facilities					
farm location, design, and layout	Is there a farm note indicate farm location and farm map on design and layout include water sources and drainage Past farm history, including environmental chemical contamination and flooding. The extend and seriousness				
irrigation facilities and drainage	Describe irrigation facilities and adequacy for the crop				
toilet	Are clean toilets and hand				

facilities and treatment system	wash facilities available and such facilities properly located Is toilet treatment system likely to be a source of microbial contamination of the farmland that will lead to contamination of the produce				
facilities for farm waste management and disposal	Describe kinds of farm wastes and methods of disposal. Are waste management and disposal methods acceptable?				
other mobile facilities	Safety hazard the may be posed by mobile facilities				

Part 3 Farm equipment

Requirements:

- types and design of farm equipment/tools
- cleaning, maintenance, and storage of equipment

Q: Examine the list of major farm equipment and descriptive function

Q: Are the types and design of farm equipment/tool appropriate for the tasks to be performed and likelihood of cross-contamination during use

Q: Is there a person responsible for cleaning and maintenance of farm equipment

Q: Are their appropriate procedures established for cleaning and maintenance of equipment and are such practices considered acceptable

Q: Is the storage area for the equipment acceptable

Part 4 Hygienic farm practice

Requirements:

- General farm hygienic condition
- farm chemical application (see example on guidelines for establishing information required in managing agro-chemicals)
- use of manure and biofertilizer
- domestic farm animals
- use of sanitizing chemicals
- farm chemical disposal and waste treatment/management

Q: In hygienic conditions of the farm in general acceptable

Q: Does the farm use any prohibited/banned chemicals and indicate the likely risk of such use

Q: Is there any reference or record of result of pesticide residue analysis available

Q: By examining the list of farm chemical application and withhold period describe in “Farm Care”, is MRLs likely to be a problem

Q: Is the produce a high microbial risk as a result of the use of manure and biofertilizer

Q: Is there any measure to exclude domestic farm animals especially during harvesting

Q: Are the list of sanitizing chemicals provided and the use of such chemicals and practice acceptable

Part 5 Hygienic harvesting practice

Requirements:

- hand washing
- protective clothing against cross-contamination
- harvesting tools and field container
- on farm produce cleaning/washing and grading facilities
- stocking/grading area
- disposal of unacceptable produce

Q: Do harvesters practice hand washing before harvesting

Q: Do harvesters washing hand after visit to toilets

Q: Are the harvesters provided with protective clothing in order to protect produce from microbial or chemical contamination

Q: Likelihood of harvesting tools in causing microbial or chemical contamination

Q: Are field containers has smooth surface to reduce fruit damage

Q: Are field containers cleaned to ensure free from chemical, microbial, and foreign material that may harm the produce and/or consumers health

Q: Are harvesting tool and field containers stored in clean area

Q: Does produce washing area on farm has amply supply of clean water,

Q: Are on-farm produce-grading facilities adequate, in term of protection of harvested produce from microbial, chemical or physical hazards

Q: Is the produce stocking/grading area in a clean and orderly condition

Q: Is the procedure for the removal of fallen fruit and disposal of off-grade produce acceptable

Part 6 Water sources and usage

Requirements:

- water for human consumption
- source and quality of water for irrigation
- water used for harvesting and washing produce
- water used for sanitation purpose

** Check each question for either “pass” or “not pass”, or a ranking of “1 for non-compliance” as “2 for major”, “3 for minor”, “4 for observation” and “5 for compliance” or a score system of 5. Excellent performance, 4. Good active performance, above average 3. Some activities, average performance, improvement required in a set timeframe, 2. Below average performance, need to increase/improve activities, and 1. Little activities, require immediate improvement*

Model or Next Performance Standards for Farm Hygienic Practice

Performance Standard Categories	Score*	Comment/Observation	Performance Improvement
Part 1 Personnel hygiene practice			
Part 2 Farm and facilities			
Part 3 Hygienic farm practice			
Part 4 Hygienic harvesting practice			
Part 5 Farm equipment			
Part 6 Water sources and usage			

** Score: 5. Excellent performance, 4. Good active performance, above average 3. Some activities, average performance, improvement required in a set timeframe, 2. Below average performance, need to increase/improve activities, and 1. Little activities, require immediate improvement.*

(3) Packinghouse Audit Working Paper and Example of Checklist on Packinghouse Hygiene:

Part 1 Personnel hygiene practice

Requirements:

- employee clothing and accessories
- employee health
- employee cleanliness and hygienic behaviour

Q: Are employees wearing clean clothing and foot wears during operation

Q: Are employees' personal health acceptable, is there any provision of first aid for the employees

Q: Are employee personal hygienic behaviour acceptable

Part 2 Premises and facilities

Requirements:

- location, design and layout: ample area for packinghouse operations from incoming fruit, treatment, packing areas to container loading
- internal structure and fitting: clean, hygienic, well-managed packing station with efficient air circulation, lighting and temperature controls
- separation of areas for postharvest activities, purchasing and inspection, treatment, holding area and warehousing
- toilet facilities and treatment system: establish personal hygienic practices include facilities for hand washing, canteen, toilet, and personal lockers
- facilities for packinghouse waste management, drainage and disposal
- other mobile facilities

Q: Is the brief company profiles, map on location, and schematic chart on packinghouse design and layout available

Q: Examine packinghouse process flow

Q: Are the premises clear of litter and waste

Q: Is the areas for packinghouse operation sufficient, separation of areas for different activities and its adequacy for the protection and maintenance of produce quality

Q: Are clean toilets and hand wash facilities available and such facilities properly located

Q: Is the packing area sufficiently lighted efficient air circulation and are lights in the packing line shielded to prevent broken glass from getting into produce

Q: Packing line areas maintain a clean and tidy manner

Q: Describe kinds of packinghouse wastes and methods of disposal. Are waste management and disposal methods acceptable?

Part 3 Equipment

- types and design of packinghouse equipment/tool
- cleaning, maintenance, and storage of equipment

Part 4 Hygienic packinghouse practice

Requirements:

- maintain packing areas storage areas and the grounds: in clean good sanitary condition
- establish a packinghouse pest control programme
- monitor and maintain facilities regularly
- postharvest chemical application
- use of sanitizing chemicals
- packinghouse pest control programme
- waste disposal and treatment/management

Part 5 Hygienic handling practice:

Requirements:

- well-trained and motivated staff and workers
- hand washing practice
- protective clothing against cross-contamination
- handling tools and grading line
- produce
- cleaning/washing and grading facilities
- stocking/grading area
- disposal of unacceptable produce

Part 6 Water quality and usage in packing establishment

Requirements:

- water for produce washing
- recycled water
- water used for sanitation purpose

Model or Next Performance Standards for Packinghouse Hygienic Practice

Performance Standard Categories	Score	Comment/observation for action	Performance Standards
Part 1 Personnel hygiene practice			
Part 2 Premise and facilities			
Part 3 Hygienic packinghouse practice			
Part 4 Hygienic handling practice			
Part 5 Packinghouse equipment			
Part 6 Water quality and usage			

Annex 3

ISO/IEC Guide 65 Compliance Audit Checklist/Working Document

ISO/IEC Guide 65 was prepared by the ISO Committee on Conformity Assessment to specify general requirements that a third-party operating a product certification shall meet if the certification body is to be recognized as competent and reliable. The process of accreditation a certification body is usually the responsibility of an authorized national competent authority or an international recognized accreditation body.

The following examples are used as partial guidelines used for assessing ISO/IEC Guide 65 Section 4 on requirements of the organizational structure and management of the certification body, and, section 5, on certification body personnel. The working document is an example of approach that can be used for self-assessment by the certification body or audit by accreditation body as a part of certification body approval process in compliance with ISO/IEC Guide 65 requirements by the accreditation body.

Sub-cause	Question No.	Guidance	* Status	** Action
4.1.1	Are there stated policies and documented procedures for operation	Availability of policy statement and procedure document		
	Does the procedure support nondiscrimination	Look for nondiscrimination statement or barrier to certification		
4.1.2	Is service available to all	Look for such statement		
	Are there any apparent undue financial or others	Enquirer the source of financial support and income		
	Is access conditional upon the size of the operation	Should have no such statement		
	Is access conditional on membership or group	Should have no such statement		
	Is access conditional on number of existing certification	Should have no such statement		
4.1.3	Are there available of evaluation criteria in the “standard”	Note and referred to standards the available of evaluation criteria		
	Preparation of published standards and necessity of explanatory documents	Competency in the formulation, scope and availability of such standard explanatory documents on request		
4.1.4	Does certification processes related to defined scope	Check for certification processes requirements related to scope		
4.2.a	Does the status foster confidence of impartial	The organizational status should indicate its independency		
4.2.b	Organizational responsibility on certification activities	Statement on organizational responsibilities		
4.2.c. 1	Management committees & responsible persons	Statement on management responsibility		
4.2.c.	Policy steering committee	Statement on committee		

2		responsibility		
4.2.c. 3	Certification committee	Statement on committee responsibility		
4.2.c. 4	Policy implementation	Appointment of quality management representative		
4.2.c. 5	Finance personnel	Statement on responsibility		
4.2.c. 6	Top management	Statement on authority and responsibility		
4.2.c. 7	Committee on technical issues	Statement on technical responsibility and demonstrate competency		
4.2.d	Legal entity/status of the certification body	Demonstrate organizational “article”		
4.2.e	Organizational structure including stakeholder participation in certification system	Demonstrate documented organizational structure and responsibility Review on components of the Policy Committee		
4.2.f	Independence between inspection and certification	Indicate inspector not involved in certification decision		
4.2.g	Organizational rights and responsibility of certification activities	Scope and responsibility of the organization		
4.2.h	Liability arrangement	See liability /insurance statement		
4.2.i	Have financial stability for operation	See financial statements/financial logistics		
4.2.j	Have sufficient qualified personnel	Have sufficient qualified personnel in relation to work loads		
4.2.k	Have quality system	Review quality manual		
4.2.l, m,n,o 1,o2, o3,p				
4.3	Taken steps to evaluate conformance to meet with the relevant product certification system			
	Specified relevant standards or parts based for certification	Ask for standards based for certification		
	Observe the requirements for suitability and competency of body and personnel	Observe “quality” of the organization and personnel		
4.4.a	Take full responsibility of subcontractor work	See contract agreements. Must retain required issues and certification decision		
4.4.b	Contractor is competent and complies with requirements of this guide	See contractors qualifications		
4.4.c	Signed agreement with contractor	See the signed consent agreement		

4.5.1	Commitment and documented quality policy and objectives	Interview management and see quality policy statement		
	Communicate with personnel on quality commitment	Interview personnel at functional levels		
4.5.2. a	Quality system relevant to the guide established, maintained and implemented	Management appointment of quality management representative for such activities		
4.5.2. b	System performance and review	See section on management review and corrective/preventive action		
4.5.2. c	Documented quality manual and elements included	Review quality manual for all elements		
4.5.3. a	Quality policy statement	Review quality policy		
4.5.3. b	Organizational legal status and ownership	Examine legal ‘article’		
4.5.3. c	Name and qualification of management teams and listed certification personnel	Check personnel rosters and qualification		
4.5.3. d	Organization chart and line of authority	See organization chart		
4.5.3. e	Description of organization and committees	See organization brochure		
4.5.3. f	Documented policy and procedure for management review	See management review procedure and record		
4.5.3. g	Procedure for document control and other administrative procedures	See document control procedure and other procedures		
4.5.3. h	Job descriptions of personnel perform quality activities	See file on job description		
4.5.3. i	Procedure for staff recruitment and training programme	See recruitment procedure. See identification of training need and programme		
4.5.3. j	List of subcontractors and approval evaluation system	See list of subcontractors. See approval evaluation system		
4.5.3. k	Procedure of handling non-conformities	Procedure of denying certification		
4.5.3. l	Procedure for decision on issue and denying certification	Review certification procedures		
	Procedure for controlling the use of certification documents	Review control of certificate and the use in marketing		
4.5.3. m	Policy and procedures for appeals, complaints and disputes	Demonstrate such statements and procedures/forms		
4.5.3. n	Procedure for conducting internal audits	See internal audit procedure and record of audit result		
4.6				
4.10	Legal arrangement to safeguard confidentiality of the certification activities	See statement on confidentiality arrangement		

	Producer's consent for the disclose of information	See statement on producer's consent to disclose information		
5.1.1	Competency of certification body personnel	Review general backgrounds of key decision makers		
5.1.2	Documented and up-dated job description of personnel	Review list of personnel and job description		
5.2.1	Define minimum qualification for competency of inspection and certification personnel	Review relevant criteria for inspectors and certification personnel		
5.2.2. a	Require from person to comply with confidentiality and independence in certification process	Demonstrate such statement in signed contract or document		
5.2.2. b	Require from person to declare prior/present association with producer	Demonstrate such statement in signed contract or document		
5.2.3. a, b, c, d, e, f	Maintain up-dated resume of personnel involved in the certification process	Resume of person involved in certification process: to include the following Name and address Organization affiliation and position Educational qualification and professional status Experience and training on certification Date of most recent records Performance appraisal		
6				
7				
8				
9				
10				

** Ratings on status to comply with requirement of the sub-clause: 5. Compliance, 4. Observation, 3. Minor non-compliance, 2. Major non-compliance, and 1. Non-compliance.*

***Action: 4. No action required, 3. Increased activity or improvement suggested, 2. Demonstrated action or improvement required before next audit, and 1. Immediate action or improvement required.*

Annex 4

An Example of ISO Guide 65 Accreditation Body Quality Manual (Adapted from Accreditation for Organic Certification Bodies Prepared by Agricultural Marketing Service, USDA)

A third-party operating accreditation service is required to have a documented quality manual including the quality policy statement and procedures of management. The follow is a simplified quality manual suggested here for an Accreditation Body that provides assessment for agricultural produce certification bodies. It reduces the amount of paper work as required in ISO Guide 65 while maintain in accordance with accepted international norm. The manual should indicate reference documents as to the instruction of the manual. The manual may cover essential headings as follows:

- (1) Policy statement
- (2) Scope
- (3) Availability of service
- (4) Organization authority for providing service, legal status, and line of authority
- (5) Non-discrimination statement and confidentiality arrangement
- (6) Application for service
- (7) Procedure for assessments
- (8) Procedure for decision on issue and denying accreditation
- (9) Procedure for denying accreditation, appeals, complaints, disputes, suspending, withdrawal of accreditation
- (10) Certificate of compliance

The following document is prepared, as an example, for fulfilling requirements of Section 4.5.1 to 4.5.10 of the ISO Guide 65.

Title: Accreditation Body Quality Manual

Reference Documents

The following documents are incorporated by reference throughout the instruction:

- ISO Guide 65- Requirements for bodies operating product certification systems
- ISO 10011-1:1990 –Guidelines for auditing quality systems- Part 1- Auditing

(1) Policy Statement

The Office of Agricultural Standards and Inspection (OASI) Provides voluntary conformity assessment and accreditation services under ISO Guide 65 to agricultural product certification bodies to facilitate farm certification and product certification. The Office acted as an independent third party and strives to provide services in accordance with accepted practices and internationally recognized guidelines. All services are provided on free basis up to Dec 31, year 2005 and will subject to changes after this date.

(2) Scope

The policies and procedures in this document apply when providing service to agricultural product certification bodies requesting conformity assessment to the International Organization for Standardization (ISO) Guide 65 on General requirements for bodies operating product certification systems.

(3) Availability of Service

The OASI accreditation services are available to Thailand agricultural product certification bodies and international product certification bodies operation in Thailand that certify agricultural products or systems that produce, process, or distribute agricultural products. The scope of accreditation is limited in Thailand. The OASI provide registration service for International certification bodies that obtain equivalent international accreditation outside Thailand and is or wishing to operate in Thailand.

(4) Authority for Providing Service and Line of Organizational Authority

The OASI accreditation services are provided under a voluntary agreement between certification and the Office until the authority of the Accreditation Service Code is established.

The Director of the Office is the legal representative of the accreditation service of the Ministry of Agriculture and Cooperative. The personnel and committees are appointed by the Director on the principle of competency, independent, and declaration of non-conflict of interest. An Officer-in-Charge of the Accreditation Programme must be appointed. An Approval Committee will be appointed by the Director of the Office and consist of two to three representatives. A list of job description and authority of personnel and committee members must be declare and available on request.

(5) Non-discrimination Statement and Confidentiality Arrangement

All accreditation services are provided without biased for business operation bodies with legal business registration in Thailand. Services are available without regard to membership in any organization, and are contingent upon the number of certificates issued.

Conformity assessment and accreditation services are to provide confidence in the ability of the certification body to provide credible product certification services. All quality manuals and supporting documents associated with accreditation/certification processes submitted by the applicants are maintained at the OASI Accreditation Programme and are available for public inspection and are subject to complete disclosure under the Freedom of Information Act. Any portion of documentation that the applicant considers proprietary must be identified to the Office at the time of application with written justification and this is subjected to the approval of the Officer-in-Charge of the Accreditation Programme. The operation of the certification body, its certification processes, and certificates issued or denied generally are not part of the confidentiality arrangement unless otherwise specified by the certification body and approved.

(6) Application for Service

Persons interested in the conformity assessment and accreditation services as stated may contact the OASI. Applicants may complete the Application Form issued by the Accreditation Programme along with the following:

- (1) A letter requesting conformity assessment service, office address and its legal status.
- (2) A complete quality manual as described in ISO guide 65, section 4.5.3.
- (3) The scope of the certification activities includes previous clients certified.
- (4) Published documents describing the certification services offered.

Upon receive of applicant's intent, the Accreditation Programme will

- Prepare a desk-top review of documents provided and accept or denial of application

- Provide a summary to the applicant of requested services including initial compliance audit, surveillance and monitoring activities associated with the audits.
- Appoint an auditor to be responsible for the audit.

(7) Procedure for Assessments

Upon acceptance by the applicant, the assessment procedure is conducted as follows:

- Auditors conduct a detail on-site audit at the applicant's place of business.
- Auditor conduct assessments based on a procedure as defined by the Accreditation Programme.
- Auditors hold a closing meeting to report and conclude the audit.
- Auditor forwards the finding to the Officer-in-Charge at the Accreditation Programme.
- An Approval Committee review and provide recommendation based on the following:
 1. The certification body address all elements of ISO Guide 65
 2. Clearly define the scope of the certification service
 3. Have demonstrated an effective and credible certification programme
 4. Have necessary financial resources

(8) Procedure for Decision on Issuing or Denying Accreditation

- Granting accreditation: the Director of the Office may grant accreditation to applicant after completion of the desk review, fulfill the requirement during compliance audit, and recommendation by the Approval Committee.
- Denying accreditation when the applicant failure to submit necessary document, fail to provide objective evidence during the course of the initial compliance audit, fail to provide access of applicant's record when requested by the auditor, present false or misleading information at any point in the accreditation process.
- The certification of accreditation is set by The Accreditation Programme for 1 year.

(9) Procedure for Appeals, Complaints, Disputes, Suspending, and/or Withdrawal of Accreditation

- Appeals, complaints on the accreditation decision must be made in writing within 30 days after the decision to the Officer-in-Charge.
- The Officer-in-Charge may suspend or withdrawal accreditation when there is misuse or misrepresentation of the certification. Disputes concerning accreditation or as result of accreditation activities should be submitted in writing to the Officer-in-Charge who should response with the steps to be taken within 30 days.

(10) Certificate of Compliance

- A certificate of Compliance will be issued stating the location and scope of the programme evaluated and the valid date.
- The certification body may made reference, for example, product certifications are accredited under ISO 65 guide by the Office of Agricultural Standards and Inspection is associated with its certification activities
- No claims shall be used on certified products unless the certification body conducting compliance audit includes test on validation of product using official product standards or specifications.

Introducing TISTR Agriculture Assurance System AA 2002

Abstract

The development of TISTR Agriculture Assurance System, AA 2002, is based on TISTR's long and close association with the fresh fruit exporting industry in Thailand. The objective of this document is to introduce a flexible, simple, user-friendly quality assurance system that will meet the requirements of international norms while appropriate under a developing condition. It is to be used as a guide for the preparation of other associated quality documentation and provides description of its implementation.

The main feature of the AA 2002 incorporates the methodology known as the "Plan-Do-Check-Act" (PDCA), the risk assessment process of the Hazard Analysis and Critical Control Point (HACCP), and the management principles of the ISO 9000. The system is flexible and operates under a balance-and-check manner suitable for the fresh produce industry and it is user-friendly without the interpretation and implementation problems of the ISO 9000. The AA 2002 is presented and explained in a simple practical tabulated form and its system descriptions provide explanatory notes using durian as an example.

The TISTR AA 2002 consists of four elements:

- 1. Commitment: customer-focused and analysis the needs and goals*
- 2. Synthesis: use of decision making tools, design and establish the resources, tasks and processes needed to achieve goals*
- 3. Product realization: operation at functional levels from purchasing, treatment to shipment and production control and service provision*
- 4. Assessment: analysis the constraints, review and continual improvement*

The tabulated quality manual also itemized system requirements for each element. This enables the system to be audited.

Introduction

The TISTR Agriculture Assurance System 2002 (AA 2002) was prepared by the Postharvest Technology Department, Thailand Institute of Scientific and Technological Research (TISTR), under the financial support of the Thai Research Fund. It is developed under the realization that the industry needs to look at the total quality feature of the operation through a systematic, analytical and preventive manner rather than problem solving piece meal approach as in the past. It is intended to be flexible and dynamic taking into consideration the unique feature of the fresh produce industry and the ever-changing market scene.

The design of the AA 2002 is based on a PDCA methodology that is a quality management analytical tool that stood the test of time while working in a total quality environment. PDCA are incorporated into the four elements of AA 2002, commitment for "P", synthesis for "D", product realization for "C" and assessment for "A." System requirement descriptions provide interpretation of AA 2002 as to "why" and "what" the elements meant including selected examples suggesting key procedures as to "when", "where", "who" and "how" processes or quality activities could be done. Quality system planning is much simplified and presented as tabulated quality plans. Several quality plans may be developed for different scope of activities in order to assist the implementation of the quality systems and each can be used to complement others or used independently. One important point is that mutual beneficial supplier relationship is enhanced in the export of fresh produce because pre-harvest factors play a very important determinant role in the final quality of the fruit.

The preparation of AA 2002 is only the first step in the establishment of a quality assurance system for fresh produce exporting industry as it operates in Thailand. The document was subsequently

revised by TISTR in an agreement with the Department of Agriculture and will be put into trial use with selected packinghouse operator that handles fresh durian for export.

Terms and Definitions

This terms and definitions, and system requirement descriptions are valid for the purposes of TISTR AA 2002 requirements. Some follow the definition defined in ISO/FDIS 9000 used by all users of quality management system whereas some are specifically defined taking into consideration the inherent characteristics of the fresh produce and the unique feature of the industry.

Terms related to management

Quality. Degree to which a set of characteristics fulfils requirements.

Quality policy. Overall intentions and direction of an organization related to quality as formally expressed by top management. The policy generally provides a framework for the setting of quality objective.

Quality objective. Something sought, or aimed for, related to quality. Quality objectives generally are based on the organization's quality policy or specified for relevant functions and levels in the organization.

Quality requirement. Quality need or customer expectation that is stated, generally implied or obligatory.

Quality management. Coordinated activities to direct and control an organization with regard to quality. Direction and control with regard to quality generally includes quality policy and goals, quality planning, product realization process and control, and continual quality improvement.

Quality Control. Part of quality management focused on fulfilling quality requirements.

Quality assurance. Part of quality management focused on providing confidence that quality requirements will be fulfilled.

Quality planning. Part of quality management focused on setting quality objectives and specifying necessary operational processes and related resources to fulfil the quality objectives.

Quality plan. The result of quality planning. It is often prepared to ease the use and understanding of the more complex quality manual. It is simple, flexible and suited to small growers and small exporting firms. May be used as a stand-alone document presented to the customer or for management within the company. A quality plan may cover a specific operation or activity and used by a particular operator to perform only the relevant part of the responsibility.

Terms related to process and produce

Quality characteristic. Inherent characteristic of a product (produce), process, or system related to a requirement.

Total quality characteristics. Total quality characteristics of fresh produce include both inherent and assigned characteristics such as produce features, price, people, place, performance, purpose, productivity, profit, perception, and promotion.

Requirement. Types of requirement, e.g. product (produce) requirement, quality management requirement, and customer requirement. For fresh produce in case of export, produce requirement includes produce quality required by the customer, obligatory produce safety levels, and legislative requirements such as plant health, Sanitary and Phytosanitary measures (SPS), as laid down by the importing country.

System activity. A basic part of the process shown the major activities to be carried out when following the system in a logical order.

PDCA. Deming's Plan-Do-Check-Act methodology. Plan: establish the objectives and the processes to deliver results in accordance with the quality policy and customer requirement. Do: policy deployment and implement the processes. Check: monitor and measure processes and product and report the results. Act: take action for continual improvement of product, process, or system. Use PDCA as an analytical tool for decision-making, risk assessment, quality planning or continual improvement.

HACCP. Hazard analysis critical control point.

Traceability. The ability to trace the origin of produce, the processing history or the distribution and location of the produce during and after delivery.

Continual improvement. Recurring activity to increase the ability to fulfill requirements.

TISTR AA 2002 System Requirements, Descriptions and Selected Examples:

Commitment to quality policy

Quality policy indicates overall intentions and direction of an organization related to quality as formally expressed by top management. The quality shall be relevant to the goals of the company and the needs of its customers. Each company shall draft its own policy statement indicating commitment to quality related to its own specific circumstances. A statement of commitment should relate to the business goals of the company and the needs of its customer, and how to satisfy customer needs, involvement of stakeholder/staff, and ensure the effectiveness of the quality management system and its implementation.

Examples of quality policy statement:

The management of the company is committed to provide trustworthy and efficient services of raw material procurement, systemized packinghouse operation and delivery of quality fresh fruit economically and reliably to meet our customer's requirements.

The management of the AAA Co. is committed to satisfy its customer by providing and delivery tropical fruit to meet consumer's expectations for quality and value. The AAA Co. will perform and maintain its operation all the way from the initial raw material purchasing, planning and systemized packinghouse operation, and training of staff and associated participants including the grower/supplier and importers to conform to the company's policy and goals.

The company is committed to give its customers a reliable service with produce to meet their individual needs.

The company will maintain a system of controls over raw material sources and the production, handling and treatment of produce to ensure its safety, quality, and legality.

All staff will be involved in a system of total quality management and be trained to be competent to fulfil their responsibilities.

The requirements laid down in the TISTR AA 2002 will have the support of the management of the company.

The Management is totally committed that fresh produce from our approved growers/ suppliers are handled, processed, and delivered to the company and subsequently exported to the designated importers in a reliable and economical way.

Quality is the responsibility of the company from management to personnel at all levels.

The overall quality objectives of the company are: to provide fresh produces that are safe and legal, to meet customer expectations through effective and efficient process, to foster grower/exporter/importer cooperation

Policy statement:

The supply of fresh fruit by the company meets customers' expectations for quality and value.

Safety and legal requirements for fresh tropical fruit of the importing countries are understood and met.

Apply the Deming's Plan-Do-Check-Act (PDCA) methodology as an analytical tool for decision marking and control of operation.

The company places great emphasis on involvement of all staff and shared faith with the grower/supplier.

The company is committed to the requirements and practices laid down in the TISTR AA 2002.

Organization chart

A simple staff structure chart shows how the structure of the business and the managerial responsibilities are held within a company.

Company information data sheet

Generally, data sheet is a single page format to communicate with the customers and others that are interested in the company. Information of confidential nature should be kept secured and respected.

Example format of a company information data sheet:

Company Information Sheet				
Date: _____				
Company name: _____				
Address (Head Office): _____				
Address of the production site (if different from above): _____				
Contacts	Name	Tel. No.	Fax No.	E-mail
Manager Director				
Commercial Director				
Procurement Manager				
Sale Manager				
Production Manager				
Process Supervisor				
Field officers				
Installation/service officer				
Quality control officer				
Name of business and products supplied: _____				

Maturity level

Quality objectives and quality planning depend, to a large extent, on the maturity level of the management of the operating unit. The following table illustrates simple guidelines used in assessing quality maturity level based on performance:

Maturity Level Classification:

Maturity Level	Performance Level	Guidance
1	No formal approach	No systematic approach evident; no results, poor results or unpredictable results.
2	Reactive approach	Problem or corrective based systematic approach; minimum data on improvement results available
3	Stable formal system approach	Systematic process-based approach, early stage of systematic improvements; data available on conformance to objectives and existence of improvement trends
4	C o n t i n u a l i m p r o v e m e n t e m p h a z i z e d	Improvement process in use; good results and sustained improvement trends
5	B e s t - i n - c l a s s p e r f o r m a n c e	Strongly integrated improvement process; best-in-class benchmarked results demonstrated

Import-export business and legislative requirements

Business requirements:

1. Ensure that the produce is permitted to enter the destination country.
2. Obtain as much information as possible to ensure there is market for the produce and estimate of market size and target group.
3. Meet written or verbal agreement on the conditions/ requirements for crop variety, specifications, quantity, price, packaging, labeling, delivery time and frequency of shipping.
4. Allow for a profit of the operation and ensure that the price cover cost of fruit, packaging, transportation, insurance, and marketing costs.
5. Ensure the timing and the right kinds of transportation equipment are available when needed. Obtain necessary and correct shipping documentation.
6. Written or verbal agreement on a case-to-case basis for shipment of non-contractual supply, or of quantity or quality exceed or below specifications.
7. Written or verbal agreement on the disposal of overstocked/disqualified produce for discount sale, discards, re-routing or return to the sender.

Legislative requirements:

The legislative “Must Know” includes specific crop quarantine requirements of the importing countries, non-use of prohibited chemicals/pesticide which have been the subject of inquiry or special interest in the destination country. The “Should Know” includes SPS measures, hygienic practice, and residue limits of pesticide-crop combination, pesticide usage on minor crops, and quality/safety/labeling/packaging standards and requirements.

Minimum legislative requirements:

1. Comply with plant health and sanitary requirements during production and handling. Obtain Phytosanitary certificate in case needed by the importing country.
2. Comply with crop-pesticide combination MRLs set by the Codex and/or the trading partners.

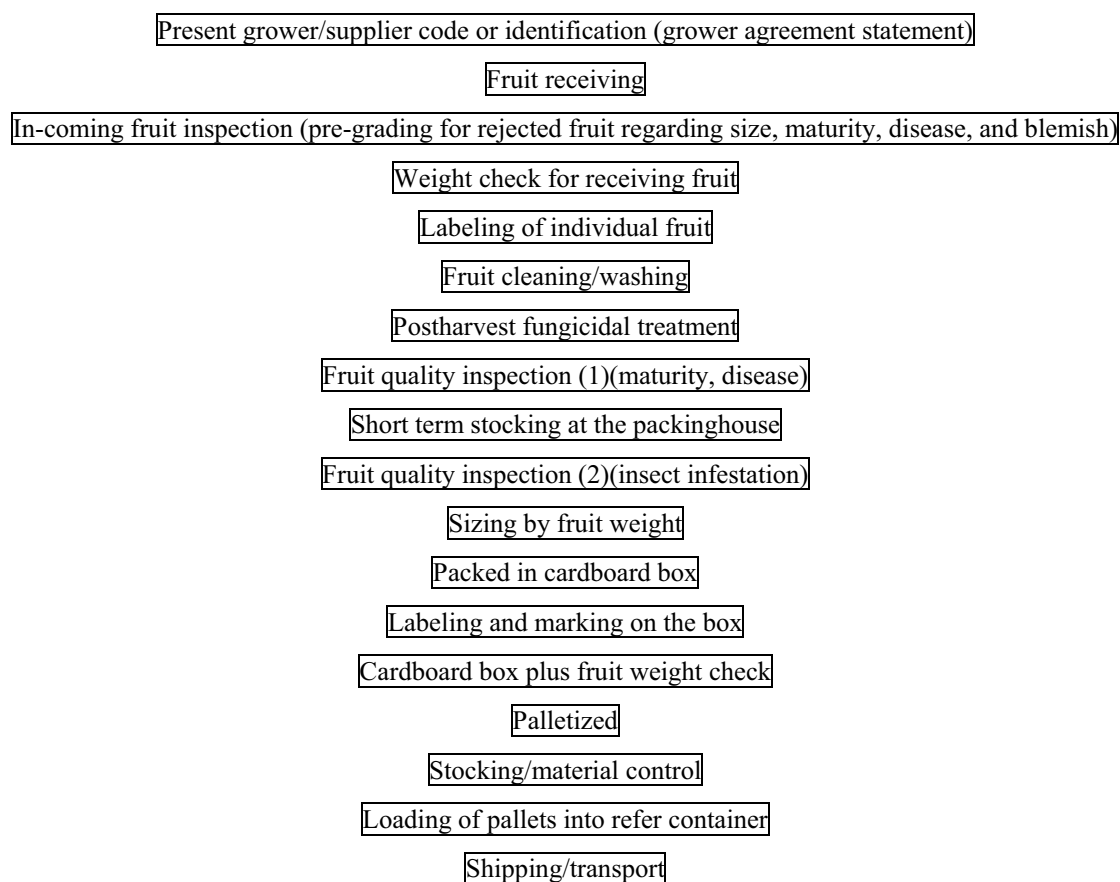
3. Practice good pesticide usage and enforced withholding period. Communication to customer/consumer on results of monitoring chemical residues if required. Establish measures for the management of residue testing and violation.

Process flow-charting

Describing packinghouse operation. It might be necessary to re-assess process path at the end of production season. The person responsible for the operational flow should be mentioned.

The following is an example of a generic flow diagram for durian packinghouse operation:

Date: _____
Authorized by: _____



Process flow analysis

Provide descriptive analysis or presented in tabulated form based on hazard analysis and risk assessment of the principles of Hazard Analysis Critical Control Point (HACCP) for each step of operation in the process chart for risks to safety and to quality. Indication of sufficiency in allocating of resources and the responsible persons at a particular step of operation, as to what, why, where, when, who and how to perform tasks, monitoring/verification at critical steps. It might be necessary to have periodic process review or product validation, for example, at the end or the beginning of production season.

Quality plan

Quality plan is generally the results of quality planning and is commonly presented as a tabulated form to focus on fulfilling quality objectives (what and why) by specifying necessary operational processes and associated procedures, and resources and responsible personnel (who, where, when and how) to carry out specific quality activities. The first tier quality plan in Table 1 is a business plan and generally developed to indicate the interrelationship of the major fresh produce exporting operational process. The example of the format here indicated the operation of a relatively matured company. Most packinghouse may, at the initial stage, limited to operation specified in the “Inspection and Treatment” in the second tier quality plan in Table 2. Other business processes are usually carried at the head office at a location different from the packinghouse. The second tier quality plan is generally related to a particular activity or a project or a specific task. In most cases, procedures, work instructions or check sheet will be needed to support more complex activities in the quality plan.

Marketing service

Packinghouse operation is largely a marketing service, an operation involves supplier management, sourcing of produce and delivery to the consumer. The dimension of marketing service requires that the operator be able to

- Identify customer requirements and product specifications
- Establish efficient and productive relationship between the supplier and the customer
- Analysis cost chain value for profit margins
- Market risk analysis, management, and communication
- Continual improve service quality

The following indicators are a suggested example of using a simple checklist to assess quality in “finance” of the company:

Indicator	Rating*				
	1	2	3	4	5
Financial control					
Accounting procedures					
Currency exchange rate					
Finance for foreign purchase					

* Rating where 1: poor, 2: below average, 3: average, 4: above average, 5. Excellent

Traceability

A produce trace back system to as far back as possible to the grower at the production site and to the importer at the market place. One of the most common practices used to ensure effective traceability from farm to packinghouse is the approved grower/supplier programme. Coding systems used include bar codes, identification numbers, stamps, stickers, markings, labels, or tags. For grower/supplier, records are required to institute a trace back systems include grower/supplier identification or code, farm/location identification, date of flowering in full bloom, date of harvest, who harvested the produce, and who handle the produce from farm to packinghouse and how. Records for the packer trace back systems include tracing grower identification, date of purchase, who carried out the produce inspection, and stock rotation, inventory, and handling and shipping procedures.

Grower/supplier development plan

The exporter usually had to establish different levels of involvement/arrangement and development plan for different grower or contractor. The exporter may “participate”; or show “concern” or take “control” of the supply of incoming fruit. The development plan can be of several kinds based on supplier ranking system. Score system as following is commonly used where 1. Little/minimum

quality activities, poor, 2. Some quality activities, below average, 3. Sufficient quality activities, average 4. Great deal of quality activities, above average and 5. Excellent, best in the group.

Monitoring based on supplier performance may be categorized as:

1. Passport system or price premium for demonstrated good critical suppliers
2. Critical supplier to be audited no less than twice a year
3. Major important supplier to be visited once a year
4. Minor important supplier to be visited

Scheduling of farm visits should be made in accordance with critical timing during fruit growth or pest life cycle or growers practice that will impart the safety and quality of the fruit.

A sample form for durian grower:

Grower name: _____		Grower identification number: _____	
Farm location: _____		Field number _____	
Tree age and (number or area): less than 5 years () 5-8 years () 9-12 years () more than 12 years ()			
First flower flush in full bloom (70%): Date _____, % of average good year (), yield estimate (ton) expected harvesting date _____			
Second flower flush: _____ Date _____, % of average good year (), yield estimate (ton) expected harvesting date _____			
Additional flower flushes if any: _____ Date _____, % of average good year (), yield estimate (ton) expected harvesting date _____			
Vegetative flushes during fruit development _____		Date of last vegetative flush before fruiting _____	
		Date of flushes after fruiting _____, _____,	
Critical rainfall record during fruit development _____		Date _____, _____, _____	
Pesticide application record: use separate record form			
Harvesting date: possible earliest date _____			
breakdown quantity of each harvest (in tons) 1 st _____, 2 nd _____, 3 rd _____, 4 th _____, 5 th _____			
total harvesting period from _____ to _____			

A sample form for field pesticide application record:

Grower name: _____		Grower identification number: _____						
Farm location: _____								
Date applied	Field name or number	Pesticide applied		Application details		Harvest date	Harvest interval	Operator name
		Product Name	Active Ingredient	Rate	Water Volume			
Checked/agreed _____ Date _____								

A sample form for postharvest chemical application record:

Owner of packinghouse: _____ Location of packinghouse: _____ Type of produce: _____						
Date of application	Lot/store identification	Chemical applied		Application details		Operator name
		Product name	Active ingredient	Rate and volume	Duration	
Checked/agreed: _____ Date: _____						

Grower/supplier agreement statement

A supply agreement statement by the grower/supplier in the understanding and the ability to comply with the legislative requirements and consumer demands of quality and safety of produce.

The statement should also include detail of the conditions to ensure:

1. Quality standards of produce.
 - 1.1 Meets the critical quality parameters e.g. harvesting at no less than minimum maturity stage, or precautionary measures taken against pest infestation of concern.
 - 1.2 Produce has been carefully handled and transported.
2. Hygienic and sanitation requirements at production.
 - 2.1 Premises where harvesting and handling areas maintained in clean and hygienic conditions. Adequate pest control measures and domestic animals are not allowed in areas of handling and storage.
 - 2.2 Adequate personal hygiene and sanitation practice.
 - 2.3 Produces are packed /transported in clean containers /vehicles.
3. Safety of produce regarding pesticide and chemical usage.
 - 3.1 Must not use any prohibited pesticides specified in the regulations.
 - 3.2 Encourage the adoption of integrated pest management system.
 - 3.3 Competence (extension) person shall review proposal on pesticide usage on the crop, use only approved pesticides, calibration of equipment, application methods and enforce withholding period. A pesticide usage record form or activity log is used and retained by the grower/supplier and for possible inspection by an authorized person designated by purchaser or official authority.

The agreement must be renewed annually and copied retained by the grower/supplier and the company for at least three years.

Raw material purchasing

Establish a system of purchasing fruit. Produce specifications or quality chart should be displayed and known to grower/supplier including information on the quantity and price of the day. Purchase only from approved grower/supplier or equivalency to ensure fruit purchased from the grower/supplier met the critical safety and quality parameters required by the destination market.

Raw material inspection

Establish a system of fruit inspection. The area should be adequately lit and equipment, facilities and areas for inspection must be available. Inspections must be carried out by trained and

competent staff. Inspection for specified quality criteria such as for maturity grade, odd-size/shape fruit, diseases and insect infestation, and mechanical bruising. For early season crop, it might be necessary to conduct 100% inspection of each individual fruit for maturity grade. For premier grower with good record, inspection may be reduced to only on samples. Inspectors should be aware of the variables on production affecting fruit quality and the changing of fruit quality with

Date of purchase	:	_____
Inspector name	:	_____
Grower/supplier ID No. or code	:	_____
Produce variety	:	_____
Time of receipt and inspection	:	_____
Total of consignment	:	_____
Quality and condition of produce	:	_____
Critical quality parameters at specific period or for specific market	:	_____
Weight or count of accepted produce	:	_____
Reasons of reject	:	_____

time. This may require having access to farm note of the grower. A simple raw material purchasing and inspection report may be needed for total lot or for each individual grower as follows:

Quality in purchasing

Checklist for quality in purchasing

Indicator	Rating*				
	1	2	3	4	5
Buying methods and techniques					
Specifications (include tolerance levels and flexibility)					
Evaluation of suppliers					
Buying order procedures, progression, and communication					
Term of payment					
The cost of holding cash					
Filing and documentation					

* Rating where 1: poor, 2: below average, 3: average, 4: above average, 5. excellent.

Legislative, safety and quality requirements

Legislative requirements.

Current legislation requirements on phytosanitary certificates vary considerably from country to country. Those implemented in Japan, Australia and USA are more stringent than those in Europe, Hong Kong and Singapore. The exporter must have access to sources of such information. For many countries, most tropical fresh fruit and vegetables are exempt from the need to be accompanied by a phytosanitary certificate. However, imports are expected to be free from pests and diseases and are subject to random checks on arrival in the country by the authorities. The provision of a phytosanitary certificate will expedite clearance of a shipment through customs.

Safety requirements.

The pesticide residue safety issue is under increasing pressure from consumers. At present, there are basic requirements that imports are not permitted to contain pesticides residues in greater amount than in MRLs established by the Codex although there are variations between country with

some being higher and some being lower than the Codex values. The control procedures for pesticides also vary quite considerable. The requirements that produce is clean and fit for consumption is taken as the norm. Requirements that production met particular hygienic and sanitation standard at farm and packinghouse are not strictly enforced. However, exporters should bear this new emerging trend in mind and to be in a position to comply when the legislation is enforced. Though relatively low risk, microbial pathogens associated with fresh produce are of increasing concern. Some microbial pathogens that have been associated with fresh produce are in the following:

Examples of microbial pathogens associated with fresh produce:

Microorganism	Incubation period	Symptoms	Infectious dose	Source	Examples of produces associated with outbreaks
Bacteria					
<i>E.coli</i> O157:H7	2 to 5 days	Watery diarrhea often containing blood, abdominal pain. Can lead to hemolytic uremic syndrome and kidney failure especially in children	10 to 1000	Animal feces, especially cattle, deer and human	Apple cider, alfalfa, spout, lettuce, radish spouts
<i>Salmonella</i> spp.	18 to 36 hours	Abdominal pain, diarrhea, chills, fever, nausea, vomiting	10 to 100, 000	Animal and human feces	Alfalfa spouts, apple cider, melons, tomatoes
<i>Shigella</i> spp.	1 to 3 days	Abdominal pain, diarrhea, fever, vomiting	10	Human feces	Lettuce
Parasites					
<i>Cryptosporidium</i> spp.	1 to 12 days	Profuse water diarrhea, abdominal pain, anorexia, vomiting	<30	Human and animal feces	Apple cider
<i>Cyclospora</i> spp.	1 to 11 days	Watery diarrhea, nausea, anorexia, abdominal cramps (duration 7 to 40 days)	Unknown, probably low	Human feces, others?	Raspberries, basil, lettuce
Viruses					
Hepatitis	25 to 30 days	Fever, malaise, anorexia, nausea, abdominal pain, jaundice, dark urine	10 to 50	Human feces and urine	Frozen strawberries, lettuce

Quality requirements.

Generally there are no legislative quality standards for tropical fruit and vegetables for most countries. Thailand's export markets of fresh produce lie mainly in Hong Kong, Taiwan and China and its neighboring countries in Malaysia and Singapore. The markets for fresh produce are very competitive in terms of price and quality and even lower quality produce at a right price usually could find a place in these countries. Minimum requirements are effectively set by the trade and largely depend on the targeted market. However, it is relatively uncommon for importers to make specific requirements of their exporters, and most often provide little guidance. The quality standards are best set by the quality levels that the exporters/importers wish to achieve, the requirements of market sectors and the competition in term of price, quantity, and variety in the market at the time.

Sampling of fresh fruit and vegetables

The quality inspector should determine the sampling size in a way as to be able to assess the lots. The bulk sample should comprise of the following minimum quantities whenever a consignment is to be decided unsatisfactory or non-conformity for specific characteristics of interest. The following is based on an interpretation of International Standard ISO 874-1980 (E) and Codex Draft code of practice for the quality inspection and certification of fresh fruits and vegetables CX/FFV 00/12, at step 6 of the approval procedure, on sampling procedures for fresh fruit and vegetables. The level of sampling depends on the frequency and severity of the risk and the effective preventive precaution needs to be taken. It may be appropriate to increase or reduce the number of samples taken:

For packages such as boxes or cartons

Number of package in the lot	Number of packages (increments) to be taken
Up to 100	5
101 to 300	7
301 to 500	9
501 to 1000	10
Over 1000	15 (minimum)

For products in bulk

Mass of lot in kilograms (kg) or total number of bundles in lot	Total mass of sample (increments) in kg or total number of bundles to be taken
Up to 200	10
201 to 500	20
501 to 1000	30
1001 to 5000	60
Over 5000	100 (minimum)

For large items of produce (Over 2 kg per unit) the increments shall consist of at least five units.

Critical quality parameters

In a packinghouse operation, quality parameters are defined differently by different packinghouses and may change with time, season, locality or market. The packinghouse operator may wish to establish several quality requirements as equally important or in order of importance. For exporting fresh durian, there is no compromise for immature or over-ripe fruit, physiological abnormality of the aril as a result of vegetative flushes during fruit development, watery core all considered critical quality parameters and allowance for these quality defects need to be established. Other reasons of reject include fruit rot caused by *Phytophthora* and *Diplodia*, presence of surface insect or quarantine pests, mis-shaped or odd size fruit. Since many quality defects are not apparent externally, preventive measures in the field are more effective than inspection at the packinghouse.

One of the critical quality parameters of durian that the fruit inspectors pay special attentions at the point of purchase is the maturity stage at harvesting. Since durians are new to many people, high quality in taste is essential to increasing importer and consumer willingness to try and buy the fruit again and again. The most common maturity indices used for durian are summarized in the following:

- Number of days from anthesis to harvesting. Under normal growing conditions, there is a close relationship between flowering and harvesting time. Durians normally take 90 to 135 days between full bloom and physiological maturity, depending on variety. For example, for Kradum and Chanee, about 90 to 100 days, and for Mon Tong and Kan Yao, 120 to 135 days. This range may be influenced by the position of a fruit on a tree, growth vigor of the

tree, irrigation, fertilizer applications, timing of vegetable flushes and floral development and temperature prevailing during fruit development. Individual trees will flower and set fruit over several weeks. The fruit on one tree are therefore of differing ages. Thus, harvesting of each fruit has to be selective. This is a most objective method used at present and is frequently used in combination with other parameters.

- Colour change of the rind. Colour changes from fresh waxing green to slightly rusting with appearance of bloom or dry look or freckles on the rind, or crookedness of the abscission layers on the rind.
- Dryness of spines: browning and slightly drying up of the tips of spines. This can be done by visual examination and by the feel of running finger nail lightly over the tip of spines.
- Physical changes to the peduncle -the short durian fruit stem. A slight swollen (about 2 to 3 cm ring) of a portion of peduncle close to the abscission break point. Roughening or sandy on the peduncle surface. Increase in stiffness of the peduncle felt by a slight swing the fruit. Changes associated with exude from xylem of the freshly cut stem that there is a decrease in viscosity and increase in sweetness of exudes.
- Acoustic method by tapping at the equatorial or lower part of the fruit where tapping sound change from tight (pang-pang) to loose (pong-pong). This is the method currently used most extensively in determining maturity stage of fruit at harvest. As the harvested fruit ripen, tapping is also used to determine the eating ripe stage.
- Colour of the aril change from off-white to tinge or blotch of pale yellow, creaming to yellow. The extent of such a change may differ in cultivars. Because it is a destructive method, it is most often early in the season for random check of questionable suppliers.
- % dry solid of the aril tissue.
- Colour of the seed coat change from pale cream, light brown, to reddish brown as the fruit matures.
- Measuring the interval after harvest and the start of the climacteric. This provides a very good indicator of the physiological changes of the ripening fruit and an estimation of potential shelf life and transportation time. However, it has no practical application in determining maturity at the time of harvest.

Maturity stage of fruit at harvesting is the single most important determinant of fresh durian quality. Due to poor eating quality, consumer will not accept durian harvested immature even the price is low. Harvesting immature fruit occurs often especially early in the season when the supply is short and the price is high. Harvesting immature fruit occurs often especially early in the season when the supply is short and the price is high. The score for maturity stage may be set at a range, at the high end or the low end, depending on markets. High disease score is assigned for fruit harvested during raining season or peak or late season when markets slow down, fruit quality deteriorates as a result of increase in disease incidences. The examination of quality of a lot of durian is based on evaluation for the following quality factors. The maximum-minimum number of points that may be given each factor varies somewhat and this is to be set by the exporter. The relative importance of each quality factor is expressed numerically on the scale of 100 where the relative weight of maturity stage at harvesting is suggested to range from 40- 60%.

Quality factors	Score point range
Maturity stage of fruit at harvesting	40-60
Disease and insect infestation	10-30
Size	10
Shape	10
Mechanical injury, surface blemish	10
Total score	100

Classification of maturity defects (cultivar: Mon Tong):

Maturity classification	Days from full bloom to harvesting	Days to eating ripe at 26 to 30C	Defect classification							
			By air				By sea			
			Acc	Minor	Major	Severe	Acc	Minor	Major	Severe
Immature <70%		More than 14 days				*				*
Mature green 1. 70-75% 2. 75-80%		12 -14 days				*			*	
		10 - 12 days			*			*		
Advanced mature green 1. 80-85% 2. 85-90%	-120 days	7 -9 days		*			*			
		5 -7 days	*				*			
Incipient ripening 90-95%	120 - 135 days	3 -4 days	*							*
Ripening to ripe >96-100%	>135 days	0 -2 days				*				*

(Suggested Acceptable Quality Levels or AQL on maturity defect is 15%. For durian for export, fruit with severe maturity defect is not allowed.)

The following on classification for durian size and shape is based on the information in “Durian Grade Standards” established by the Department of Agriculture.

Classification of size defects:

Var.	Size classification (kg/piece)	Defect classification			
		Acc	minor	major	severe
Chanee	<1.5				*
	1.5-<2.0			*	
	2.0-<2.2		*		
	2.2-<4.0	*			
	4.0-<4.2		*		
	>4.2				*
Mon Tong	<1.8				*
	1.8-<2.0			*	
	2.0-<2.5		*		
	2.5-<5.0	*			
	>5.0			*	
Kratum	<1.3				*
	1.3-<1.5			*	
	1.5-<2.0		*		
	2.0-<4.0	*			
	>4.0				*
Kan Yao	<1.0				*
	1.0-<1.5			*	
	1.5-<2.0		*		
	2.0-<3.5	*			
	3.5-<4.0		*		
	>4.0				*

(Suggested Acceptable Quality Levels or AQL on size defect is 20% for durian for export)

Classification of shape defects:

Var.	Shape classification (# of locules)	Defect classification			
		Acc	minor	major	severe
Chanee	<2				*
	2			*	
	3		*		
	4	*			
	5	*			
Mon Tong	<2				*
	2			*	
	3		*		
	4	*			
	5	*			
Kratum	<2				*
	2			*	
	3		*		
	4	*			
	5	*			
Kan Yao	<2				*
	2			*	
	3		*		
	4	*			
	5	*			

(Suggested Acceptable Quality Levels or AQL on shape defect is 20% for durian for export)

Other quality parameters, e.g. insect infestation, an assessment programme include risk analysis may need to be established. The necessity of risk assessment programme is mandatory where there is regulatory requirements. Information on the degree of likely risks, the seriousness of problems under normal conditions and factors such as locality effect, weather conditions, time of the year and the extent of control over growers and packer/exporters affecting infestation probability are required in establishing a suitable field surveillance programme. Final product inspection also provides additional verification. Records of such monitoring or inspection need to be made available.

In determining compliance or non-compliance in an inspection programme, sampling plans and inspection procedures need to be set up. See Applied Supplier Programme for a suggested inspection procedure. Also included in ASP are information that serves as basis for inspection and grade or compliance determination, and examples of different sampling plans, Acceptable Quality Levels (AQL), allowances for quality factors, and score sheet.

For final production inspection where there is a more than one-day delay after purchasing, further sample inspection should be carried out prior to loading or to export to ensure that the fruit are able to without the journey. Since most fresh produce quality deteriorate after harvest and are not fixed during transport, a guideline on FOB Good Arrival Guidelines Table is required.

Critical safety parameters

Fresh produce, especially fresh tropical fruit, generally is considered low safety risk. It is unlikely that any pesticide residue will exceed the Maximum Residue Level (MRL) if grower is knowledgeable and pesticide application is used in accordance with the Good Agricultural Practice. In most cases, a statement that no prohibited chemicals have been used and sufficient withholds period after pesticide application should be sufficient to meet customer's requirement. Some

importing country may request the result of pesticide residue monitoring by the competent authority in the exporting. See: Risk assessment for pesticide residue analysis”.

Critical safety parameters may vary from country to country. For examples, some countries may concern with the use of certain prohibited pesticide and residue levels established in the regulations, some may allow only the use of pesticides in the positive lists, while others placed restriction on meeting the MRLs established for the crop. In that case the MRLs establish under Codex is generally accepted.

Safety criteria in many cases, especially for fresh vegetables and some fruit items, include microbial contamination, sanitation and hygienic practice during production and handling and cross contamination during transport. General packinghouse sanitation practice is suggested to minimize safety hazards at the workplace:

- Clean, hygienic, well-managed packing station with efficient air circulation, lighting and temperature controls
- Ample area for packinghouse operation from loading of incoming fruit, treatment, pack out to container loading
- Separation of areas for postharvest activities, purchasing and inspection, treatment, holding area and warehousing
- Maintain packing areas, storage areas and the grounds in clean good sanitary conditions
- Establish a packinghouse pest control programme e.g. domestic pets and household pests
- Inspectors/ buyers establish personal hygienic practices, include facilities for hand washing, canteen, toilets, and personal lockers
- Well-trained and motivated staff and workers
- Monitor and maintain facilities regularly

Critical legislative requirements

For some produce, there may be legal requirements on quality/safety/hygienic/quarantine standards laid down by the importing country that must be complying with. . Legislative requirement may vary from country to country and also depending on crops and place of origin. Different countries also differ in inspection requirements and procedures. Obtain information from customer or competent authorities of exporting/destination countries.

Risk assessment for pesticide residue analysis

The chemical companies should provide the most current regulatory status for their chemicals and information on application. There can be wide variation in the reliability of residue data obtained. Some importing country regulatory authority or customer may require that routine, random pesticide residue analysis be carried out. In such as case, a result of residue testing of a crop may be obtained from the competent authority of the exporting country and subsequently obtain the approval of the importer or importing country authority for its adequacy. A risk assessment programme establishing priority for residue testing must draw up to include procedures and frequency of such analysis that based on the degree of risks, the seriousness of problems and the extent of control over growers and packer/exporters.

A suggested residue testing for growers and packers base on risk assessment is as follows:

Risk	Action
Use of prohibited chemicals	Withdraw from the approved grower/supplier list is case of use Farm audit and ban use of chemicals Grower/supplier agreement statement of non use of the next production year
Crops which receive a high number of	Check field application records

individual pesticides	Enforced withholding period Select samples with most treatments for residue testing
Crops which receive the highest frequency of pesticide application	Ditto
Crops which have been treated with pesticides having a long persistence e.g. harvest interval greater than 21 days	Check field application records Enforced withholding period Seek alternative chemicals Select samples with most treatment for residue testing
Product which has received a postharvest treatment or has been treated just prior to harvest to improve postharvest keeping of produce	Check records and methods of application Sample at least once per production season from each treated product held in store
Crops treated with pesticides which have been the subject of inquiry or special interest in destination country	Check with respective customers or authorities of receiving countries or their agents Minimize or ban use if required Sample at least once during production season for residue testing
Where residue of a particular pesticide/crop combination near to or above the MRL have been reported by an importing country, particularly where these samples can be traced back to source	Check field application records where the pesticide of concern has been used and identify potential problem Sample at least twice each season or three times for residue testing
Where produce is collected from co-operatives	Members crosscheck field application records. Samples from those crops with most treatment and most shortest withholding interval for residue testing Sample at least twice during the production season
Where produce is collected from new supplier or from a number of small suppliers	Check field application records Enforce withholding period

Sampling for pesticide residue analysis

Example of sampling method for residue analysis as recommended by the UK fresh Produce Consortium:

Field sampling technique: the number of samples per farmer's plot depends upon the size of the plot.

Area of plot (ha)	# of primary samples to be taken
Less than 0.5	4
0.5 to less than 2.5	4 to 8
2.5 to less than 25	8 to 20
25 to less than 250	20 to 70

For individual primary sample weights

Commodity	Crop example	Target weight
Light weight products up to 25 g	peas and beans, mushrooms, lychees, chilies, onions	250g
Medium weight products 25 to 250 g	bananas, mangoes, okras, peppers, carrots, broccoli, tomatoes oranges	500g
Heavy weight products over 250g	cabbages, mangoes (large), pineapples, durians	1 kg

Bulk product

Weight of lot (tons)	# of primary samples to be taken
Less than 10	4
10 to less than 50	4 to 8
50 to less than 500	8 to 20
500 to less than 5000	20 to 70

Packaged produce

# of packages in the lot	# of primary samples to be taken
Less than 100	4
100 to less than 500	4 to 8
500 to less than 5000	8 to 20

Labeling requirements

For fresh fruit and vegetables, the following labeling information is generally mandatory: country of origin (district where grown, or national, regional or local place name is optional), nature of produce (common name for the species is mandatory), commercial specifications (class is mandatory), identification (identification of packer and or dispatcher, name and address). Obtain information from customer or competence authorities of exporting or destination countries

Packaging requirements

At present, there are considerable variations between counties; thus, exporters need to deal with each individual. Most fresh produce packaging is classified as transport packaging. At present there appear to be no real constraints applicable to fresh produce packages. However, corrugated board recycling has been an issue and will be introduced soon. This may introduce difficulties for exporters who have always found it necessary to use high-quality packages. Some packaging trend are: green image packaging, set targets of 50 to 65% for recovery of packaging waste, 25 to 45 % for recycling, regulation on materials to come into contact with foodstuffs.

Container requirements

Minimum requirements:

- Container identification is documented
- Container is not damaged
- Door deals are in good condition, floor drains are open
- Container interior is clean and odour free
- Container refrigeration unit is operational and cooled to a desired loading temperature for the produce
- The unit is off during loading
- Establish loading procedure and stacking pattern

Container loading checklist

Checked by: _____ date: _____		
1. Container		
item	check here	remark on non-compliance
Container identification is documented		
Container is not damaged		
Door deals are in good condition, floor drains are open		
Container interior is clean and odor free		
Container refrigeration unit is operational and cooled to a desired loading temperature for the produce		
2. Loading		
item	check here	remark on non-compliance
Record of cargo temperature (pulp temperature)		
The refrigeration is turned off during loading of produce		
Correct cargo is loaded into container		
Package count is correct		
Produce hand load or machine load on stable unit loads, with proper bracing, interlocker, corners or strapping		
Loading pattern to facilitate air circulation, below the marked line and mark storage diagram		
3. Container operation		
item	check here	remark on non-compliance
Thermostat is set to correct temperature		
Fresh air exchange rate is set properly		
Portable temperature recorder are placed, started, and marked		
Security seal is attached to rear door and the seal number is recorded		
Shipping document		

Quality in transport and logistic

Transport and logistic planning check sheet:

Planning Indicator	Rating*				
	1	2	3	4	5
Agents and brokers: (reliability, responsiveness, assurance)					
Customs and claims procedures, insurance					
Regulatory information					
Freight mode (ship, road and air) delivery schedule speed, freight rate)					
Corrective measures in shipping services					
Planning and scheduling					
Business process procedure					

Forecasting					
Import procedures and documentation					
Letters of credit, bills of exchange					

** Rating of service providers or procedures where 1: poor, 2: below average, 3: average, 4: above average, 5. excellent.*

Checklists for self-audit or third party audit of the packinghouse.

For the exporter/packinghouse operator:

Performance Standards:

- communicate product specifications with suppliers
- comply to sanitary and phytosanitary measures and other legal requirements of the importing country in case of export
- understand the dynamic changing market requirements
- nurturing good relation with grower/supplier
- common sense handling, hygienic and sanitation of work place and personnel
- packinghouse operation (including process operation and control)
- storage, delivery and distribution control (including transportation cost and taxes)

Quality Parameters and Key Indicators:

General packinghouse sanitation practice:

- clean, hygienic, well-managed packing station with efficient air circulation, lighting and temperature controls
- ample area for packinghouse operations from loading of incoming fruit, treatment, pack out to container loading
- separation of areas for postharvest activities, purchasing and inspection, treatment, holding area and warehousing
- maintain packing areas, storage areas and the grounds in clean good sanitary condition
- establish a packinghouse pest control programme
- monitor and maintain facilities regularly
- well-trained and motivated staff and workers
- inspectors/buyers establish personal hygienic practices include facilities for hand washing, canteen, toilet, and personal lockers

Packinghouse operation process control:

Process control related to raw material:

- open display/communication with supplier on product specifications/standards
- careful handled of produce from the farm to the packinghouse
- provide growers code or identification number, and traceable records on pesticide application
- development plans for growers who supplying the fruit and identify the growers who need special attention
- ensure growers have continuity of supply and traceable farm records

Process control related to postharvest treatment

- careful handling at every stage of the packinghouse process regarding quality and safety

- effective purchasing and inspection system for in-coming fruit for maturity, rots, insects, bruises, and any other undesirable characters, proper grading, sizing and packing
- acceptable and effectiveness postharvest treatment
- pay special attention to critical quality parameters and precautionary preventive measures. For durian, for example, holding period to assess insect infestation in case of need

Process control related to postharvest operations

- washing water source, water quality and waste water management
- good packaging, appropriate presentation, and labeling requirements as specified by the importing country
- understanding and monitoring fruit behaviour during storage, ripening, and shelf-life test, access to new information

Transportation

- workers should practice good personal hygiene and sanitation practice
- avoid excessive handling/mishandling
- evaluation mode of transport to destined markets
- use container loading check list
- maintain and monitor proper container temperature
- use good quality containers, ensure shipper's reliability in providing export transportation service and cost
- on-time delivery to the customer
- export documentation (bill of landing, invoice, proof of origin and phytosanitary certificate (when applicable) to facilitate rapid clearance at the importing port
- reduced customer complaints and initiate preventative/corrective actions

Record keeping requirements:

- valid quality plan
 - Record keeping of packinghouse activities
-

Training. Personnel associated with growing and harvesting should be aware of GAPs, good hygienic practices and their role and responsibility in protecting fresh fruit and vegetables from contamination or deterioration. The subjects to be covered as part of the training for the packinghouse operators include:

- the nature of the fruit
- or vegetable, in particular its ability to sustain growth of pathogenic microorganisms
- the task the employee is likely to perform and the hazards and controls associated with those tasks
- the manner in which fresh fruits and vegetables are packaged including the probability of contamination or microbial growth
- the conditions under which fresh fruits and vegetables will be stored
- the extent and nature of postharvest treatment, processing activities or further preparation by the consumer before final consumption

Training should also include programmes on personal hygiene:

- the importance of

good health and hygiene for personal health and food safety

- the importance of hand washing for food safety and the importance of proper hand washing techniques
 - the importance of using sanitary facilities to reduce the potential for contaminating fields, produce, other workers, and water
 - supplies
-

Information Paper on Durian from Farm to Packinghouse

Abstract

For fresh produce, quality starts at farm. This paper provides the baseline information that is relevant to “total quality” features of fresh durian for export. The information covers the botanical description of the durian, fruit development, pre-harvest factors influencing postharvest quality, the myth on durian maturity stage at harvest, durian postharvest physiology and ripening and a brief durian exporting industry and packinghouse operation. The cause of quality problems needs to be seriously addressed before the export potentials of fresh produce can be realized.

Quality assurance has now become one of the most important marketing tools in the dynamic global trading environment. Process flow and process flow analysis are presented as a first step to start a quality management system. A brief introduction of several common quality control/assurance system options including SPS, GMP, HACCP and PDCA and their suitability for horticultural industry are discussed. Quality improvement activities for fresh produce involve many different highly individualized sectors from grower to packer. Quality performance indicators to assess as to what each sector want out of the system should be used, before the design of a quality management system.

Introduction

The durian (*Durio zibethinus* Murray) is one of the most interesting and controversial of all tropical fruits. It is highly nutritious and widely believed to possess a tonic food value. The fruit has been highly praised by the enthusiasts but many find its strong odour developed when the fruit is ripe far from glamorous, offensive to even nauseating. The firm-soft, smooth, and creamy texture of the aril gives the durian fruit a rich filling quality. The taste is sweet to sweet with a tinge of bitterness. The pleasure of eating durian is a complex sensation resulting from the interaction of these senses.

The production of durian is commercially important only to the Southeast Asia regions. The durian is now intensively cultivated in Thailand and Malaysia. Thailand is considered having the most mature and commercialized durian export industry in the region. Activities associated with its production, distribution and marketing are common rural scenes and are deeply engrained as an integral part of the culture. Now, the fruit is highly esteemed not only in its native homes but also beyond. The intra-regional trade in durian has becoming very significant. Annual production of durian in Thailand is about 800,000 tons. In Thailand, durian is grown mainly in the eastern and the southern region. Production in Changwat Chantaburi and Changwat Rayong, located in the eastern region, account for approximately 30 % of durian production of the country and contributes the greatest share of export market. Export of fresh durians, amounted to 60,000 to 80,000 tons annually valued at more than 1,200 to 2,000 million Baht, ranking durian as one of the top export earners in fresh fruit. Thailand's exports of fresh durian, by major countries of import ranked by importance are as follows: Taiwan, Hong Kong, China, Singapore, Malaysia, Indonesia, and Canada.

Origin and Distribution of Durian

The durian, a native fruit of western Malaysia and dubbed “the king of tropical fruit”, has been introduced into many countries including Thailand and neighboring islands in tropical Asia such as lower Burma, Cambodia, South Vietnam, the Indonesian archipelago, the southern tip (Mindanao and Sulu) of the Philippines, Southeastern India, Sri Lanka, and New Guinea.

The durian is a species of moist tropical regions. The durians are grown either in the wild, semi-cultivated as garden fruit, and, only recently, extensively cultivated. However, even in the equatorial regions, the production of durian remains geographically restricted despite a rather similar and narrow range in the variations in rainfall, climatic fluctuation, and daily mean temperature. Production, yield, and fruit quality vary greatly in response to environmental and growing conditions. It tolerates neither cold nor dry climate. It grows well in deep, moist, alluvial or loamy soils at an altitude, up to 300-600m and rarely seen grown above an altitude of 800m. It may require a relatively dry period to induce flowering in some regions.

The durian belongs to the family of Bombacaceae of the Malvales order. There are at least six better known and described *Durio* species in the family. *Durio zibethinus*, the common durian, is the most economically significant and cultivated species. In Malaysia and Thailand, more than 200 cultivars in each country, have been recorded. Criteria, such as leaf and vegetative growth; flower and floral development; characteristics of the fruit, the rind, the spine, the aril, and seed development, and fruiting behaviours; have been used for the classification of species. Variations within clones in the species are common and influenced by the tree age, cultural practices, and growing conditions.

Durian variety has been a subject of numerous studies. Most of the cultivated clones are chance selection from seedlings that resulted from open pollination. The classification and grouping of cultivated clones is based either on one particular parameter of interest or a combination of various criteria. Each country appeared to have developed its own cloning system. Major durian cultivars grown in selected Southeast Asia countries are: Malaysia, D2, D10, D24, D99, D145, and 3 hybrid clones MDUR 78, MDUR 79, MDUR 88; Indonesia, durian sunam, durian sukun, durian sitokong, durian, simas, durian, petruk, durian otong (Mon Tong), durian kani (Chanee); the Philippines, DES 806, DES 916, Chanee, Mon Tong, Umali, CA 3266, and Thailand, Kradum, Chanee, Mon Tong, Kan Yao, and Kob. In Thailand, the most prized of all is Mon Tong.

General Botanical Description

The durian tree is a large evergreen handsome tree reaching 27 to 45m tall. The trunk is erect, straight, slightly enlarged at the base. The bark is rough, grey or reddish-brown. For a mature tree, the shape is reminiscent of a large elm. The crown is conical-pyramidal shape, dense, and composed of stout, horizontally arranged branches. Shoot growth appears to be continuous. . Fruiting starts 5-7 years after planting and there is mostly one harvest per year. The tree shows strong seasonality. There are usually 2-5 vegetative flushes during the season. Pruning after fruit harvest aids in synchronized vegetative flushes. The monsoon climates and agronomic practices also strongly influence the timing and the intensity of vegetative activities. Synchronized floral initiation occurred usually after a relative dry spell of about two weeks. Depending on the number of flower flushes in a season, flowering period lasts one to two months. Under normal condition, vegetative growth ceased during flowering and fruit development.

The durian fruit is about the size of a pineapple. The almost woody hard thick rind (skin) is covered with stout and sharp spines. The tip of the hexagonal stubby to pyramidal spines, 1 – 1 ½ cm long, is not curved. The shape of the fruit varies from globose, ovoid, elongate to ellipsoid and may grow as large as 30 cm long and more than 15 cm in diameter. Each fruit weighs from 2 to 5 kg up to 7 to 20 kg. Fruit, when ripe, dropped unopened. Rind thickness varies with the cultivar and the tree age. The colour ranges from dark green, greyish green, greyish brown-green to greenish yellow. The harvested fruit, when ripe, splits open along the natural abscission lines on the rind into five segments to reveal the edible aril each containing one up to seven chestnut-like seeds. The aril fills each segment in single row.

The aril varies in colour, thickness, texture, odour, and taste. The colour of the aril ranged from white, cream, yellowish, and golden yellow, pink or orange. These characteristics of the aril are cultivar specific. There are changes in the colour of the aril, associated with the maturation of the fruit. Such a change is subtle but considerably enough to be used as one of the most reliable maturity indices. The number of aril units and sizes within a fruit may vary greatly from segment to segment. The seed embraces by the aril and colour of the seed coat changes from white, creamy to reddish brown as the fruit matures. The development, numbers, and size of the seed vary with the cultivar. In some superior cultivar, the seeds are compressed and abortive. For some cultivars, notably Chanee and Mon Tong, a high percentage of fruit has abortive embryos. The embryos disintegrated. The fruit are able to reach normal maturity with well-developed aril whereas the seeds are compressed and shriveled. The fully developed seed germinates easily but lose viability quickly in a matter of weeks. The aril content ranged 15-35% of the fruit weight. Aril content exceeding 20% has been one of the goals in durian breeding programme. The rind/aril/ seed ratio for the Mon Tong cultivar of Thailand that has been highly praised for its high aril content, is about 6:3-3.5:0.5-1. Most of these fruit characteristics are inherent of cultivars, but variations in cultivars are common.

Floral Biology and Fruit Set

The flowers are borne in clusters directly on the main trunk and on lower or large branches. The inflorescence is corymbose and each may bears more than 20 flowers but is sometimes reduced or thinned to only a few. The pedicel is 5-7 cm long. The large flower is 5-7 cm long. Calyx sacculate flattened at base. The calyx is composed of 2 parts, the epicalyx of 2-3 free sepals and the interior of 3-5 broadly cut, fused sepals. The corolla consists of 4-5 free petals that are white, streaked with green. Other *Durio* species may have red petals. The numerous stamens, white or creamy, are grouped into 4-5 bundles. There are 5 – 12 anthers on each filament. Anther dehiscence occurs by a slit. Pollen grains, plump and sticky, are solely dependent on insect vectors for pollination. The ovary is superior, ovoid with a long slender style.

The fully developed flower yet to open in 24 to 36 hour is already receptive. As the flower opens, it reveals a receptive yellow stigma. The length of the style of a fully opened flower is almost three times as that of the unopened flower. Natural pollination takes place at night for a rather limited time. The flower is fully open at 5:00 p.m. and anther dehiscence occurred around 7:00 p.m. giving off an odour of sour milk that attracts flies and other insects, which aid in pollination. By 11:30 p.m., the anther lobes fall off and only the pistil remains on the flower clusters. Viability of pollens from dehiscent anthers ranged 80 to 95 %. The pollen grains remain viable until the next morning or up to 18 hours after anthesis. The flower may remain receptive until 6:00 am the following morning. The unfertilized pistils remained on the tree up to four days after pollination. There is a high degree of self-incompatibility. In Malaysia, the norm is 20 to 25% fruit set. To improve fruit set, artificial pollination by reciprocal cross is recommended and this practice is considered essential to obtain good

commercial crops for some cultivars. Artificial pollination has also been recommended to improve fruit shape for some cultivars.

Water stress is by far the most distinct climatic factor in its effect on flower initiation. Environmental conditions and agronomic practices that influence nutritional effect on vegetative/reproductive balance also influence floral development and the subsequent success of fruit setting. It should be emphasized that the physiology of durian flowering and fruit setting is not isolation of external factors but rather the interactions of numerous internal and external development processes coming into play. Because of the factors listed, seasonality and crop cycle play a very prominent role in the yield of the durian.

Fruit Development

The relative growth rate of rind, aril, and seed was reported. The fruit showed a sigmoid growth curve. Growth is rapid until approximately 13 weeks after pollination and gradually slows down until maturity. For durian, the rind and the aril are considered as distinct and separate physiological entities; growth curves of the rind and the aril are distinctly different at each stage. The fruit reach full maturity in 14 to 18 weeks depending cultivars. Time to maturity is also influenced by environmental and growing conditions.

Fruit development is arbitrarily divided into four overlapping stages. This is to be used as a general indicator and not to be used to predict the optimum date of harvest.

Stage 1: Development phase of chiefly the embryo and the rind. This lasts for approximately 5-6 weeks after pollination. One week after pollination, the ovary starts to enlarge. The colour of the young fruit changes from light brown to light green. In the second week, the spines start to develop as fine soft protuberances. At this stage, the rind constitutes the majority of the weight and there is little aril growth. By the fifth week, there is a more rapid increase in length than width.

Stage 2: Development phase of the rind and the beginning of aril and seed development. This stage lasts from 6 weeks to 10-11 weeks after pollination. The growth rate of the rind is faster than the aril up to this stage. The amount of aril growth remains limited. The fruit reaches about one-third in size of a fully developed fruit.

Stage 3: Development phase of the aril. This stage lasts from 10-11 to 13-14 weeks after pollination. The growth rate of the aril is rapid and exponentially for about 3 weeks. The growth of the rind is beginning to slow down. Seed develops within the aril. The seed texture is initially jelly-like and solidified as the seed matures; and seed coat colour remains creamy.

Stage 4: Aril and seed coat maturation stage and one of the most important stages as far as fruit quality is concerned. During the final week or so, there is cessation of growth. This stage is vital for quality development of the aril. Only fully matured durian fruit after stage 4 have the desirable texture and flavour. The seed coat matures to reddish brown in colour that is regarded as a good and reliable indicator of maturity stage.

Fruit drop may occur during the early period and continue up to stage 3 of fruit development. The percentage of fruit drop differs amongst cultivars; for example, more serious for cultivar such as Chanee than Non Tong. The first fruit drop occurs within 2 weeks after full bloom as a result of failure in fertilization. Subsequent fruit drops are possibly due to a physiological imbalance between the processes of active rind growth and aril development. When thinning is required especially in “on”

year, this is usually done 4-6 weeks after fruit set. Two to three subsequent thinning may be necessary. The final number of fruit to remain on the tree is usually decided and reached at stage 2.

Splitting of the ripe fruit occurred along the abscission layer on the rind. The degree of ease in fruit splitting varies with cultivars and the degree of ripeness. For some varieties, a full ripe fruit that fall off the tree may remain unopened.

Preharvest Factors Affecting Postharvest Quality of Durian

General

Preharvest factors include uncontrollable environmental conditions prevailing during fruit development and at the time of harvesting, and controllable agronomic practices such as the application of fertilizers, chemicals (including plant hormones), and irrigation. Each factor alone or in combination influences the nutritional status of the tree thus upsets balances between vegetative and reproductive growth, fruit development, and maturity stage and these factors strongly affects subsequent quality, ripening, and storage life of the fruit. For the production of high quality durian, grower/harvester requires expert knowledge about crop-environment interactions, the state of vegetative and reproductive activities and their effects on fruit quality, and timely management of agronomic inputs to reduce the adverse impact of these factors to fruit quality.

Environment and cultural practice

Fruit set, fruit growth and development, and fruit quality are known to be very sensitive to environmental conditions. The effects and seriousness of water stress differ depending on stages of the development of the rind/aril. Durian requires large amount of nutrients for fruit production, especially potassium that is required in translocation and sugar-starch conversion and may have been associated with the storage quality as reported in other fruit. Drip irrigation and the use of certain type of manure may affect the flowering-to-harvest period. However, there are only limited reports available on the effect of climatic factors and cultural practices on fruit development.

Vegetative flush

Intensive vegetative flush that occurred during flowering to fruit development is one of most serious factors affecting yield and fruit quality. Vegetative activities during flowering and young fruit developing stage caused flower/fruit drop resulting in low overall yield.. The effect on fruit quality is often not apparent externally until the harvested fruit are ripe. The nutrient competition and imbalance in the sink-source relation influences the physiological states of vegetative growth and fruit development. The seriousness of such effects on fruit quality depends on the extent of flushes and the stage of fruit development when flushes occur. Vegetative flush results in floral/fruit drop, particularly during flowering and stage 1 young fruit of less than 3-5 weeks. For fruit at stage 2 fruit, up to 10 –12 weeks after fruit set when the rind has undergone expansion and some aril growth, the effects are not apparent externally but remain detrimental to the fruit by causing fruit drop, miss-shaped fruit and affecting the quality of the aril. For stage 3 fruit at exponential development phase when the aril is rapidly expanding, fruit might become seriously miss-shaped as a result. In addition, arils of such fruit when ripe become abnormal in colour (mottled) and texture, without external sign of abnormality. The ripened aril may either soften or soften un-uniformly and eating quality is poor lacking the rich sweet smoothness associated with normal ripening. The effect of vegetative flush on fruit during the last stage of maturation phase, the last two weeks before harvesting, is less severe.

Physiological disorder

Watery core of the fruit, occurred, as a result of water imbalance within the almost mature fruit late in the season, is another serious preharvest problem affecting postharvest quality. This problem coincides with the rainy season and is serious only in some growing areas and more serious in some cultivars, Chanee for example. It is known that the effects of water stress on quality are influenced by the stage of fruit development and tree (root) growth. During the stress period, fruit development is slowed. When the rain occurs early in the season after a long stress, due to lack of activity of durian root, and slow fruit development, the root system is often not restored. Water imbalance that resulting in watery core of the fruit is not serious. Continuous rainfall during late stage of fruit development caused abnormality in the aril as a result of water and nutrient imbalance. When the rain occurring late in the season, root activities are restored, aril development active while rind development slowing down, water intake leads to increase in interior turgor that results in cell rupture, thus, the “water core” of the fruit. The extent of problem may also be influenced by fruit load since relatively heavy loads cause a marked delay in maturation resulting a more serious “watery core” of the fruit. The fruit with watery core do not have apparent external signs.

Harvest maturity

Maturity stage of fruit at harvesting also influences eating quality. In commercial operations, durian fruit are harvested at a minimum harvest maturity stage. The minimum commercial maturity stage generally is defined as the stage that the fruit is physiologically mature, or mature green, and capable of normal ripening process after harvest, to acceptable eating quality while still allow the fruit a reasonable shelf life for marketing or transport.

Some preharvest effects on fruit quality may have external signs but most often not. Thus, in an exporting operation, a traceability system to preharvest conditions during fruit development is very important to ensure durian of good quality.

Insects and diseases of durian and chemical used in control

Disease caused by fungi *Phytophthora palmivora* (Butler) Bulter is one of the most serious preharvest as well as postharvest problems. The pathogen is prevalent in all durian-growing regions in Thailand and is one of the most serious limiting factors in durian growing. Disease problems are more serious under high humidity or rainfall. It also causes serious postharvest fruit rot especially where field protection against the disease is inadequate or when the fruit are harvested under rainy conditions. Fruit rot after harvest takes 3 to 7 days to develop. The pathogen is soil borne, waterborne, can be carried by plant debris, farm tool or crawling insects or snails. Fruit in contact with the soil are liable to be infected or spores may be splashed by rain onto fruit lying close to the ground. Integrated disease management from farm sanitation and hygiene, disease monitoring and routine application with fungicides may provide manageable *Phytophthora* control. Integrated management of the disease also should consider the epidemiology of the pathogen, the vectors, and cultural and agronomic practice to reduce the level of field inoculum. Field control measures include one or a combination of the following measures 1. Diseased bark, trunk or shoot are scraped or removed and painted with a recommended fungicide 2. Soil drench around the infected and adjacent trees with recommended fungicides 3. Trunk painting or trunk injection with recommended fungicides in combination with soil drenching and 4. Control the presence of pathogen in the soil with antagonistic soil fungi such as *Trichoderma* sp. or other effective microorganisms. Postharvest fungicidal dipping provides the harvested fruit a double insurance against the disease. Mechanical injuries to the rind such as bruising, impact, or vibration, during harvesting, handling, and transportation provide easy entry of fruit rot

microorganisms. Fruit rot, caused by *Lasiodiplodia* sp., a weak pathogen but with wide presence, gained entry to the rind mainly through the wound or mechanical injury, have been associated with postharvest disease at the market place.

Commonly used agricultural chemicals are grouped in the following:

- *Fungicide*: Metalaxyl, carbendazin
- *Insecticides*: Carbaryl, Chloryrifos, Endosulfan
- *Herbicide*: Glyphosate

Application of ethephone, an ethylene-releasing chemical has been used on a variety of crops preharvest for controlling fruit development process or inducing ripening. The application is mostly done in liquid form at ambient temperatures. It is now widely used preharvest; for example, for flower induction in pineapple, fruit ripening in peppers and tomatoes. For durian, little has been known on the effect on preharvest application of ethephone on fruit development. Some growers apply ethephone as a spray a few days before harvesting. This preharvest application might possibly improve the colouration of the aril and hasten, to a certain extent, fruit development processes. However, the effects of such application on eating quality, which occurs in the last week of fruit development, are probably minimal. However, this preharvest practice should be used with caution.

Ethephone has been approved for the postharvest fruit ripening of bananas and tomatoes and degreening of lemons. During application, ethylene is liberated in ethephone solution at pH above 5, approximately 7 fluid ounces of active ingredient adding soda pellets (approximately 3 ounces/7 ounces of fluid) to release one cubic foot of ethylene. Fresh produce treated with ethylene liberated from ethephone response similarly as to ethylene gas treatment. Ethrel has been used widely in durian export operation.

Harvesting Season and Harvesting

Number of days between anthesis and harvesting is affected by the nutritional state of the tree influenced by environmental factors and agronomic practices. The fruit normally takes 90 to 135 days between full bloom and physiological maturity, depending on cultivars and cultural practices. The yield and the fruiting season may vary and shift considerably with weather from year to year. In the main durian production area in the eastern Thailand, flowering of durian occurred after drier months of the year in December to February and the fruit matures in March to June. The earliest available fruit for export from the eastern Thailand may shift between February and April. Export season starts mid March and lasts till early July with peak around late April to June. The peak-harvesting season, in the southern Thailand and Malaysia, is about two-three months later, in June and August. In the humid regions of Malaysia and Indonesia, the durian may have two fruiting seasons: in early March and April, and in late September and October. However, off-season production is now possible and the fruit are available almost all year round.

A tree will flower and set fruit over several weeks depending on the number of floral flushes during growth as influenced by the nutritional state of the tree, tree age and environmental conditions. The durian fruit on one tree may therefore be of differing age. Fruit are selectively harvested over the season. In Thailand, durians are hand-harvested by picker mostly work in pair or with one picker being directed as to which fruit to harvest by another usually an more experienced picker. A harvester, on the tree, picks and drops the fruit where another picker, on the ground, catches the fruit with a heavy sack by a swing. Another method is tied the fruit to be picked to a rope and lowered to the ground. Fruit left to ripen on the tree will eventually fall off. In Thailand, fruit are commonly harvested at maturity stages at 80 to 95% and fruit are seldom left to ripe on the tree and fall, which is a common

practice in Malaysia. The fruit weight at harvest is more than 80% of its final potential weight. Fruit harvested at physiological mature but not full ripe has a much milder flavour that is preferred by most Thai consumers.

Maturity Indices

Much uncertainty and controversy surround durian harvest maturity and maturity indices. Various maturity indices for harvesting durian have been suggested. In practice, it is difficult to conclude one parameter being more important or better than the other. Several criteria in combination are generally used. The grower and harvesters' knowledge, preference, and experience may influence the choice in the selective use of these indices.

The most common maturity indices used are summarized in the following:

- Number of days from anthesis to harvesting. Under normal growing conditions, there is a close relationship between flowering and harvesting time. Durians normally take 90 to 135 days between full bloom and physiological maturity, depending on variety. For example, for Kradum and Chanee, about 90 to 100 days, and for Mon Tong and Kan Yao, 120 to 135 days. This range may be influenced by the position of a fruit on a tree, growth vigor of the tree, irrigation, fertilizer applications, timing of vegetable flushes and floral development and temperature prevailing during fruit development. Individual trees will flower and set fruit over several weeks. The fruit on one tree are therefore of differing ages. Thus, harvesting of each fruit has to be selective. The judgment of maturity based on this can be predicted with more than 70% certainty. This is a most objective method used at present and is frequently used in combine with other parameters.
- Colour change of the rind. Colour changes from fresh waxing green to slightly rusting with appearance of bloom or dry look or freckles on the rind, or crookedness of the abscission layers on the rind.
- Dryness of spines: browning and slightly drying up of the tips of spines. This can be examined by observation and by the feel of running fingertip lightly over the fruit surface.
- Physical changes to the peduncle -the short durian fruit stem. A slight swollen (about 2 to 3 cm ring) of a portion of peduncle close to the abscission break point. Roughening or sandy on the peduncle surface. Increase in stiffness of the peduncle felt by a slight swing the fruit. Changes associated with xylem of the freshly cut stem that there is a decrease in viscosity and increase in sweetness of exudes.
- Acoustic method by tapping at the equatorial or lower part of the fruit where tapping sound change from tight (pang-pang) to loose (pong-pong). This is one of the methods currently used most extensively in determining maturity stage of fruit at harvest. As the harvested fruit ripen, it is also used to determine the eating ripe stage.
- Colour of the aril change from off-white to tinge or blotch of pale yellow, creaming to yellow. The extent of such a change may differ in cultivar. For example, Chanee has a more intense aril colour as the fruit matures compared with Mon Tong. It is a destructive method and is one of the most reliable indicators determining maturity stage at harvest.
- % dry solid of the aril tissue.
- Colour of the seed coat change from pale cream, light brown, to reddish brown as the fruit matures.
- Measuring the interval between harvest and the start of the climacteric or days after harvest to eating ripe. It provides a very good indicator of the physiological changes of the ripening fruit. It may be used in commercial term in various ways especially to provide an estimation of potential shelf life and transportation. However, it has no practical application in determining time of harvest.

Fruit maturity is judged by a combination of above mentioned maturity indices mostly subjective criteria. Judgment of maturity stage for harvest is partly science and partly art. Harvester may have an important role to play as to which fruit to harvest based on a combination of maturity indices of his choice, however, decision as to when to harvest depend on the requirement of packer and the price prevailing at the same.

Fruit maturity stage at harvest in a commercial operation can be categorized into three stages:

1. **Full mature stage:** Fruit of more than 90% physiological maturity. Incipient ripening has already commenced while the fruit is on the tree. The aril may already begin to soften or may not begin to soften. Subsequent storage life of the fruit is less than 3 to 4 days. The fruit has excellent eating quality. However, due to its strong odour, they are not suitable for export by air or by sea.
2. **Mature green stage:** Fruit between 75 to 90% physiological maturity. Incipient ripening has commenced while such a fruit is still on the tree but without any sign of aril softening. Days after harvest to eating ripe is about 5 to 9 days for the “*advanced mature green stage*” fruit or 80 to 90% physiological maturity, and up to 10 to 12 days for the “less” “*mature green stage*” fruit or 75 to 80% physiological maturity. For an expert durian eater, any fruit of less than 85%, or 7 days after harvest to eating ripe, is not acceptable. Fruit at both mature green stages are considered commercially mature and suitable for export by air or by sea depending on intended mode of transportation and transport duration to the market. Fruit will ripen to acceptable to excellent eating quality.
3. **Immature stage:** less than 75 % physiological maturity. Such fruit when harvested may or may not be able to undergo climacteric processes. The aril colour off-white may still soften but eating quality is inferior. Fruit has no commercial value because of poor eating quality.

Postharvest Physiology

Respiration and ethylene production

The durian fruit is a climacteric fruit. Harvested durian showed no preclimacteric lag phase and a relative high rate of respiration indicating that incipient ripening has already initiated before harvesting while the fruit are still on the tree. Harvested fruit exhibits a very marked climacteric rise in respiration associated with ripening. There is a parallel increase in ethylene production. Initial rates of CO₂ production of harvested fruit ranged from 40 to 60 ml CO₂ per kg-hr depending on the variety and the fruit maturity at harvest. Days between harvest and climacteric peak were reduced as maturity stage of fruit at harvest advances. Rate of respiration peaked after 3 to 10 day being quicker for the more advanced and to reach approximately 100 to 180 ml CO₂ per kg-hr, being higher for the more advanced fruit. Durian is a high producer of ethylene. Peak ethylene production rates ranged from 8 to 20 μ l C₂H₄ per kg-hr as the maturity stage advanced.

The rates of respiration and ethylene production are commonly measured from the whole fruit. For the durian fruit, the rind and the aril are structurally and physically different. The rind is woody and the edible aril tissue is rich in nutrients and sweet and is less than 40% of the whole fruit based on weight. This suggests that the rind and the aril are distinctly different physiological entities. The tissues of the rind and the aril were studied separately, a substantial break from routine methods of using the whole fruit. For durian, it is possible to identify the levels of different parts of the tissues contributing to the rate of CO₂ and ethylene production. Studies have indicated that component parts, the rind and the aril, contribute differently to the ripening process of the whole fruit. Fruit ripening and tissue softening process developed separately and expressed differently in the rind and the aril tissue. Carbon dioxide production rate was generally 2-3 times higher in aril discs than in the rind discs. The rind tissue of the

ripening durian also appeared to have a high capacity for ethylene biosynthesis despite of the woody structure. The study also suggests a possible interaction between the rind and the aril and this need further clarification.

Ripening process

Distinct aroma, indicating fruit becoming eating ripe, could be detected prior to the respiratory peak. Softening of the aril coincides with a sharp increase in pectin methylesterase, polygalacturonase, and soluble pectins. Internal CO₂ and C₂H₄ concentration of fruit were 2% and 0.2 ppm, when mature green and increased 4-6 % and 3 to 6 ppm, when ripe. Ripening is irreversibly initiated when the internal concentration of naturally produced ethylen increases from 0.1 to 1.0 ppm. Ripening of fruit is normally done at ambient temperature ranging from 25 to 30C. For durian, depending on maturity and temperature, the ripening process generally requires 5 to 7 days and 7 to 9 days for advanced mature green fruit and less mature green fruit respectively and 2 to 3 day for full mature green fruit, before the fruit become eating ripe. The process of ethylene- initiated ripening of a *less mature green stage* fruit requires about 4-5 days. . The process of ripe fruit becoming overripe is very rapid. For most cultivars, the ripe fruit rapidly loss their prime eating state in a matter of one to two days. The process of ripe fruit becoming overripe is more rapid in some cultivar such as Chanee than in other such as Mon Tong.

Since incipient ripening of mature green durian has already initiated before harvesting, ripening can only be slowed down to a limited extent under low temperature. Shelf life of fruit of mature green stage at 28 C is about a 5 to 9 days. Similar fruit could be stored at 15C about two to three weeks.

The effect of controlled atmosphere

Ripening of fruit stored in low O₂ and/or high CO₂ atmosphere has been reported. Low O₂ at 10% is sufficient to cause a significant reduction in fruit respiration and ethylene production, however, the onset (initiation process) of ripening was not delayed and fruit quality was not affected. Carbon dioxide concentration above 4% has been reported to show inhibitory effect on ripening. Ripening of fruit stored at O₂ at 5 to 7.5 % was inhibited during the two-week period but recovered when fresh air was subsequently introduced. Fruit stored in 2% O₂ for two weeks failed to resume ripening even when removed to air. The adverse effect of low O₂ was less significant in ripe fruit or in fruit where ripening was apparently well underway at harvest in the more advanced maturity than fruit of less degree of maturity.

Postharvest Handling Practice

Maturity stage

The final one to two week of fruit development before full mature is the most important period constitute to flavour, aroma and texture development of the aril. While it is important to harvest fruit at a stage for best eating quality, under commercial operations especially for export, harvest maturity commonly is a compromise to adjust maturity stage to accommodate market requirements. For good eating quality, the durian can only be harvested within a narrow window of about 2 weeks of the last fruit development stage, an equivalent of from 80 to 100 % of fruit maturation. Durians harvested below a minimum physiological maturity stage, or less than 70%, are considered immature and have no commercial value, as the fruit will either not ripe or ripe to inferior eating qualities.

Shelf life and storage temperature

Fruit harvested at 75 to 85% could be stored at 15 C for two to three weeks. Chilling injury occurred at 14C after long storage. Chilling damage in the rind tissue began as browning of the spines and later the whole fruit become dull brown. Chilling injury resulted in the failure of the aril tissue to soften. Chilling symptom is a combination effect of temperature and duration. The intensity of chilling symptom in rind was more severe at 14C than at 4C. Stored at 14C for a short period, the rind may not show chilling symptom. Chilling injury occurred at 14C after long storage. The rind may not shown chilling symptom when fruit were stored only for a short storage period at 4C but become permanently damaged with long storage at 4C. The degree and extend of chilling injury to the aril is also combination effect of temperature and duration and ripeness of the aril tissue. Exposure of already softened aril tissue of a ripe fruit at 0C shows no sign of chilling injury. No chilling symptom was observed in the hard aril tissue stored at 14C whereas at 4C, for a few days to a week depending on maturity stage, the aril tissue failed to soften even when fruit were subsequently removed to 22C.

Artificial ripening

Ethylene is a natural occurring plant hormone. It promotes ripening among many fruit crops and has played a very important role in the ripening of fruit. It is a common postharvest practice to accelerate and promote more uniform ripening of climacteric type of fruit such as avocados, bananas, mangos, papayas, pears, persimmons, and tomatoes prior to retail distribution. For most fruit having reached proper maturity, there are no important biochemical, chemical or physiological differences between fruit ripened natural or by externally applied ethylene. However, many tropical fruit such as tomatoes, mango, papaya and durian, eating quality of fruit artificially ripen by exposure to externally applied ethylene is generally inferior to that ripen naturally.

The degree of sensitivity to ethylene and ripening conditions such as temperature, concentration and time of exposure of ethylene treatment vary with commodities. In general optimum ripening conditions for most fruit are 10 to 200 ppm, at 18 to 25C, and 85 to 95 % relative humidity for 12 to 48 hours with the respired carbon dioxide maintained below 4%. Fruit are gassed with ethylene while enclosed in a room or chamber designed with air exchange and temperature control.

In Thailand, a simplified artificial ripening method has been used employing calcium carbide that generate acetylene, a method commonly used for bananas and mangoes, or ethephone in liquid form, used for durian, instead of using ethylene gas. Ethylene treatment in enclosed ripening room is not practical for durian because of the problems with the heat and the moisture condensation in the room generated during ripening. Ethephone is applied postharvest to the durian fruit by painting at the stem end or by dipping. For durian, an average ripening process generally requires 3 to 5 days after exposure to ethephone treatment and before the fruit become eating ripe. Fruit need not to be enclosed in a room or chamber. Externally applied ethylene gas has been used for durian during transit in the refrigerated container. This is done by throwing in a small bottle of ethylene and allowing its entire contents to be released in the enclosed refrigerated container during transit.

Wax treatment

Wax application provides a barrier on the rind surface that reduces water loss and generates modified atmospheres resulting in a reduced O₂ and an elevated CO₂ concentration within the fruit. The high CO₂ concentrated and low O₂ in treated fruit become inhibitory to ripening. Waxing treatment slows down postharvest physiological rates of the durian fruit. As a result, waxing reduces the incidence and extent of cracking of ripe fruit. However, some related waxing to increased water-soaking in the aril and fruit rot incidences and commercial waxing practice has not been well accepted.

Postharvest chemicals

The *Phytophthora* disease occurred preharvest could be so serious as to wipe out the entire orchard and could manifest as postharvest fruit rot. Both field practices and postharvest handling operation largely influence the seriousness of postharvest fruit rot. Common postharvest fungicides used to protect durian from diseases are Fosetyl Aluminum and Carbendazim to control *Phytophthora* and *Lasiodyplodia* respectively. Gibberellic acid treatment at 100 ppm shows some effects on rind dehiscence and degreening processes. Ethephone has been used to provide uniform ripening especially for the large Mon Tong fruit. Various postharvest chemicals used for durian may not be compatible. For example, ethephone is strongly acidic in water solution. At pH about 5 or above, it hydrolyses and liberates ethylene within a matter of a few hours. Most of other chemicals and especially commercial waxes are alkaline. Thus, precaution should be taken when these chemicals are mixed.

In summary, the durian fruit is highly perishable. Self-life of harvested fruit at 30 C is extremely short, only a few days and seldom last more than 10 days depending on maturity stage at harvest. The fruit must be harvested at a sufficient maturity stage to attain the flavour and desirable mouth feel characteristics of the aril. At such a physiological stage, ripening has already initiated and the harvested fruit enter a rapid climateric rise in both respiration and ethylene production without a lag phase. The rate of respiration, at about 200 ml CO₂ per kg-hr, is considered among one of the highest in fruits. The fruit is susceptible to chilling injury. Symptoms of chilling occur at a temperature below 14C. The rind turns dark brow/black and the aril unable to soften. Aril that already soften do not show chilling injury at 0C. Overripe fruit cracks at the blossom end and the market value for such fruit is significantly reduced. *Phytophthora* and *Diplodia* are found associated with pre- and post- harvest fruit rot. Effectiveness control of postharvest fruit rot could mean success or failure of an export operation.

Chemical and Nutritional Information

The most important properties in the overall perception of durian quality are flavour and texture of the aril. The creamy smooth aril owes its texture to semi-cellulose (cell wall), pectin substances (middle lamella of the cell wall) and gums. The odour is described as having two distinct notes, one very strong and onion-like, and the other more delicate and fruity or nutty. The odour varies with the cultivar and the degree of ripeness of the fruit. Satisfactory flavour can be achieved when fruit are harvested under a range of maturity stage. For some, the slight bitter taste of a fully ripen fruit in some cultivars is highly praised. The aril is highly nutritious. The food energy (calories) of durian aril at 129 to 153 calories / 100 g, compared with strawberry papaya orange, pineapple grape and banana at 37, 41-51, 45, 52, 66 and 87-131 respectively. This put durian as one of the highest in fresh fruit next to the avocado (239 cal). The protein, fat, calcium, iron and vitamin A levels are very significant. The vitamin C content is also significant and comparable with grapefruit. Total soluble solid (Brix) of ripe fruit is 36-40% or higher. It is rich in carbohydrates (19.3g), proteins (3.3g), fats (4.3g), and minerals (calcium, potassium, iron) and vitamins especially vitamin A (890 IU) and vitamin C (62 mg).

Durian Packinghouse Operation in Thailand

Brief industry profile

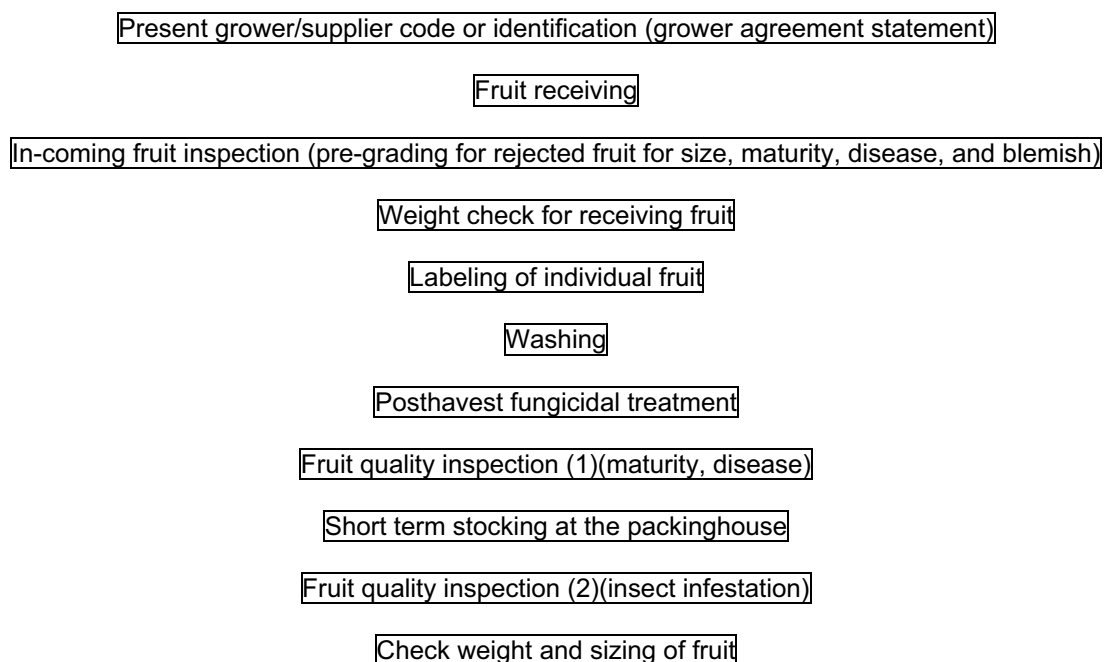
The volume of the fruit handled, the consumer requirement, previous problems experienced in the market and quality level to be achieved determine to a great extent on the set up and scale of operation of the packinghouse.

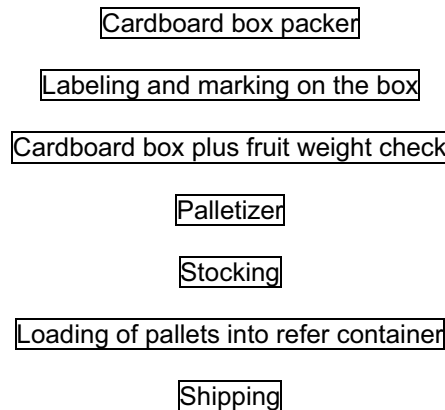
Total durian production capacity in Thailand is estimated at 800,000 tons per year. Only about 20% being exported as fresh fruit. Export industry enjoyed a boom in the 1990s when markets in Taiwan and the Mainland China were rapidly developed. Such a new demand did not reflect the future trend of the markets unless quality problems have been solved. A number of large packers operate an average turnover rate of 5 containers or more a day during the peak season down to a few days a container early or late season. With the increased exports to the Chinese markets, the packing capacities in the area have increased and mushroomed up to handle the large volume of fruit but there are also several large packing facilities in the region no longer in operation. Many new exporters with newly established channels had little marketing expertise, come in haste with economic arrangement with opportune local people with little knowledge of durian. As a result, one of the most serious problems is poor fruit quality and indicatives by mounting complaints and claims yearly by the consumer and by the importing countries' regulatory authority.

The packinghouse operation holds a vital key in maintaining the quality of produce. Packinghouse operation differs with different packinghouse. The operator's experiences, skills and the degree of entrepreneur spirits also vary. Fruit are handled in a range of different ways at different packinghouse creating a great variation in quality. Operational details are subjected to continuing changes and improvement as more information is learnt and adopted by the packinghouse operator. Investment in handling equipment was often considered not economically justifiable due to the short seasonal nature of the operation.

Process Flow

Drawing of schematic diagram of the packinghouse and flowcharting of the packinghouse operation are first step toward starting a quality management system. A flow chart provides an interrelation of the step and illustrates what is being done of each step of operation. A flowchart is often presented to the customer or for the management within the packinghouse. A generic durian packinghouse flow chart, as practiced, is presented here.





Process Flow Analysis

Process flow analysis is done by identifying at each step as to what and where problems lies and determining the severity and frequency of occurrence of risks to quality and safety, and prioritizes the corrective actions or preventive measures required. The simple analytical procedure usually starts by asking “what, why, when, where, who, and how”. Process flow analysis improves communications between workers; establish better teamwork and less dependence on the subjective judgment of a single employee.

Fruit sourcing, receiving and grading

Sourcing, receiving and in-coming fruit inspection at packinghouse is the most important crucial determinants on quality. Grower and packer/exporter interact at this step.

Production of durian in Thailand is mostly small-scaled and fragmented. The exporter sources fruit from a great number of growers and farm contractors. Qualities vary from farm to farm due to difference in growing area, micro-environmental conditions, variations in cultural practice and techniques, differences in experiences, skills and knowledge of growers about the crops and the degree of professionalism. Quality from a same grower also may vary from early season to late season or from one lot to the next.

Product standards or specifications are often negotiated between the exporter and the importer. Most packers maintain a list for fruit suppliers but grower/farm contractor are seldom penalized for supplying inferior fruit. An approved supplier evaluation programme needs to be established. Simple traceability system are suggested: a record of farm chemical use by the grower, a grower/supplier agreement on the safety and quality requirements, and a simplified supplier codes or lot marking system tracing flow path of the durian. Traceability system has to be, on one hand trace as far back to the field as possible and on the other hand, trace through packinghouse operation to the market.

The exporter will usually have many quality grades with two or more market outlets. The case of single grade, single supplier and single customer rarely exists. Even in the same importing country, requirements may vary depending on the market segments. Growers have difficulty understanding what specification to conform to. Quality, safety and even legislative requirements such as SPS measures, technical barrier to trade also vary from country to country. The information is lacking for most grower and packers.

Postharvest treatment

Postharvest treatments, involving washing and fungicidal treatment, vary greatly from one packinghouse to another. Handling procedures are continuously been improved as more information is learnt. Packinghouse operation contributes to variables in quality is more manageable than pre-harvest variables. From process flow analysis, the problems can be systematically identified, priority for quality improvement activities established and subsequently reflected and incorporated in the operation of the packinghouse.

Quality Management Systems for Fresh Produce

Emerging quality system concept in horticultural industry

People define quality in many ways. The definition of “quality” with emphasize on product standards as in the past has since evolved to a new process-based concept embracing a totality of product, process, or system features to meet consumer satisfaction or exceed consumer expectation.

Quality assurance in the fresh produce industry has gained increasing importance due largely to a greater consumer awareness for safety and increasingly demand for consistent good quality food. Because fresh produce is generally considered a low health risk commodity, fresh fruit and vegetable handlers have traditionally regulated their own actions with regards to quality, standards and safety. However, this will soon be changed as increased reports of incidences and complications of food-borne illnesses and chemical contamination associated with fresh produce. However, safety mandate required of fresh produce remain unclear. The general consensus is that fresh produce must be produced and handled in clean hygienic conditions and that the basic personal hygiene rules are observed.

Common quality control/assurance systems are briefly discussed in the following:

Sanitary and Phytosanitary Measures (SPS)

The agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) has been accepted as one of the basic instruments for trade of international fresh produce. The requirements to meet the SPS requirements differ in different products and in different countries and also subjecting to changes as the circumstance change. Member countries need to compile the information in a systematic way and develop national standards or harmonized code of practice for SPS implementation. Fresh produce, not only needs to satisfy the consumer demand for quality and safety but also needs to meet the legal and regulatory requirements of the importing countries. While SPS agreement is a legal text, the quality and safety standards are no legal binding. The increasing importance of SPS in fresh produce marketing is expected.

Good Manufacturing Practice (GMP)

GMP is now mandatory for many food sectors and may soon be suggested for use for the fresh produce. The GMP describes the proper general code of practice on plant layout, process equipment, and process control and monitoring based on scientific information or laboratory tests and over all and personnel sanitary and hygienic practice. An equivalent for fresh produce as the GMP is to the food industry is the Proposed Draft Code of Hygienic Practice for the Primary Production, Harvesting and Packaging of Fresh Fruits and Vegetables.

Hazard Analysis Critical Control Point (HACCP)

The HACCP involves the systematic assessment of all the many steps in a food manufacturing operation and the identification of those steps that are critical to the safety of the product. The HACCP analysis will produce a list of critical control points (CCP), together with operating targets, monitoring procedures and corrective/preventive action for each CCP. One of the major drawbacks in adopting HACCP in the fresh produce industry is that implementing HACCP programme could become a struggle in the absence of a clear safety mandate as for fresh fruit. Prerequisite programmes such as hygienic/sanitation practices or GMP should be in place for the HACCP to be effective. For HACCP, the need of full acceptance of the principles where the critical control points must be exercised and critical limits met is almost impossible for fresh produce operating under a system of balances where variables or control points may not be able to be measured or evaluated.

Plan-Do-Check-Do (PDCA)

The internationally recognized Deming's PDCA cycle is used to initiate a systematic self-assessment before decision on the choice and operational details of a quality management system. It is a time-tested analytical tool working in a total quality management environment. The PDCA cycle could be become a very convenient tool for quality planning for fresh produces where interaction of services, products, processes, and people is prominent.

1. P for Plan:
 - 1.1 External requirements
Establish quality objectives and quality levels based on target markets and consumers, regulatory and legal requirements of the importing countries in case of export, and business objective of the operator.
 - 1.2 Internal requirements
Define organizational structure, responsibility, and resources management of the operating units.
2. D for Do:
Development of product features and design of production processes to meet quality goal.
3. C for Check:
Production and keeping control of production process variables.
4. A for Act:
Continual improvement to achieve higher levels of performance based on information from postproduction checks, shelf-life/shipping life tests and quality indicators in the market place.

Others

Other quality management systems originated from the manufacturing sector mostly are emphasized on planned process control in assuring customers that they can purchase a product with confidence and meet their expectations. There is a move world wide for manufacturing industries to develop quality systems that comply with the international quality assurance standards as laid down in ISO 9000. However, ISO 9000 deals exclusively with quality assurance system by adherence to procedures without taking into consideration of activities such as leadership, strategic planning and customer/supplier relationship management that are vital to fresh produce industry.

In conclusion, with increasing liberation and reform of international agricultural trade, the latest scientific and regulatory thinking on the safety and quality control of perishable produce is leaning toward harmonized and mutually recognized international standards, rather than meeting the specific requirements of respective importing countries.

Quality Plan for Durian Packinghouse Operation

A simplified tabulated quality plan is useful to illustrate the initial process of documenting a quality assurance system. Most often a quality plan is prepared to ease the use and understanding of the more complex documented quality manual as often used in ISO 9000 quality systems. The quality plan, with a clean objective, can be prepared and applied at ease to a specific situation or a specified activity, for example, grower/supplier traceability, safety and quality agreement plan. A quality plan can also be developed and used for issues not in the production process such as occupational health and safety issues. It is simple, flexible, suited to small growers and small exporting firms, and to the unique, fast, and ever-changing fresh produce marketing.

It is advisable to have several quality plans. The format and level of detail in the plan should take into consideration of the level of understanding of the operator (worker) and the complexity of the specified activity. A first tier quality plan often provides an overall operation and management, and serves as a reference to indicate the relationship or interdependency of quality function groups of the packinghouse. The second level quality plan is developed for a particular activity or project, or a specific situation or complicated task in question. It should cover all important quality activities of the firm that has been identified as priorities. The second tier quality plan should indicate the acceptable quality characteristics or process conditions to be controlled and methods of control. The second level quality plan is supported by procedures, work instructions or relevant check sheets. The acceptable quality criteria or characteristics and control methods to be used must be specified.

Establishing Quality Performance Standards and Verifiable Quality Parameters

In the planning of quality management, one system is unable to set a well-defined processes for meeting the quality objectives and performance requirements for all /stakeholders/ operators in the handling chain. A clear breakdown of production/process steps with the quality goal of each sector clearly identified is essential.

The following are suggested partial lists of performance standards for specified sectors: the grower, the consumer, the distributor/handler and the regulatory authorities. The quality performance standards consist of two parts: (1) performance standards/requirements for each sector, and (2) verifiable quality parameters/ indicators respective to each requirement.

A working paper or check sheet may be developed for the purpose of self-inspection or third party audit to guide/assess the operation to achieve the desirable standards.

For grower

Performance Standards:

- grown and handled under clean sanitary conditions and basic hygienic rules observed
- good production practice with emphasis on minimal chemical use and environmental pollution
- production cost control and increase % of saleable produce
- meet quality, safety, health expectations of the consumer

Quality Parameters and Key Indicators:

General farm information and sanitation practice:

- location, surrounding and current and historical use of land
- code/lot number systems of the production areas
- clean, hygienic, well-managed farm
- accessible sanitary facilities
- training, promote hygienic practice, health and welfare of farm workers, obey basic hygienic rules and personal hygiene.
- adequate hand washing and toilet facilities
- water source, water quality and management
- reduce off-farm inputs
- promote the use of compost and animal manure include good agricultural practice for manure management, on farm recycle of farm wastes
- reduce synthetic fertilizers
- reduce chemical pesticides and other agro-chemicals
- household wastage disposal and management
- clean harvest, storage facilities, and equipment maintenance
- access to market information and price trend, understand consumer expectation

Agronomic practice:

- number of plants per areas, average yields of past years and estimation of the present year
- risk assessment on macro-environmental information and lessen seasonal effects on yield and fruit quality
- crop type and variety grown
- ferrigation monitoring/management for floral initiation and fruit set
- record of flowering date and deflowering practice
- disease/insect monitoring and curative measures as practiced
- increase in marketable fruit
- able to predict quantity based on cultural practice and micro-environmental factors
- reduce or alleviate vegetative flushes during critical fruit development stage
- the right fruit load in relation to tree size and vigor
- proper equipment calibration and maintenance

On-farm handling operation:

- proper harvesting tools/methods
- careful handling of harvested fruit, remove as much dirt and mud, reducing the risk of contamination or deterioration of fruit outside of packing facilities
- premises/fruit handling areas must be maintained in a clean and hygienic condition
- water source, water quality and management
- repair or discard damaged containers
- protect unused cleaned and new packing containers in storage
- domestic animals are not allowed in areas of production or storage
- produce quality specification in term of delivered quantities, desirable external appearance, uniform size and shape, taste and flavour, freedom from apparent diseases and inspects and good/uniform maturity at harvest
- all produce must be maintained in a clean condition and adequate protection for the produce from contaminants

Record keeping requirement:

- a file or record keeping system including pesticide and chemical usage, field activities
- grower/supplier statement/agreement on quality and safety specifications

For consumer

Quality Goals:

- meet product standards/specification
- safety and quality fruit
- healthy and nutritious to the consumer
- price flexibility

Quality Parameters:

- external appearance of the fruit, no extreme in size or shape, no rots, bruises or blemishes
- eating qualities that combines all the good eating sensation
- low or no pesticide residues
- price reflect demand-supply

For packer/distributor/exporter**Performance Standards:**

- understand the dynamic changing market requirements
- product specifications and communication with suppliers on requirements
- nurturing good relation with grower/supplier
- good handling and packinghouse operation
- handling cost control (including transportation cost and taxes)
- comply with sanitary and phytosanitary measures and other legal requirements of the importing country in case of export
- reduce rejects or complaints

Quality Parameters and Key Indicators:*General packinghouse sanitation practice:*

- clean, hygienic, well-managed packing station with efficient air circulation, lighting and temperature controls
- ample area for packinghouse operation from loading of incoming fruit to pack out
- separation of arrival fruit, separate inspection area, treatment and holding area
- maintain packing areas, storage areas and the grounds in clean good sanitary condition
- monitor and maintain facilities regularly
- well-trained and motivated staff and workers
- inspectors/buyers establish hygienic practices such as hand washing before inspecting produce
- establish a pest control system

Packinghouse operation and process control:

- provide growers code or identification number, and traceable records
- aid growers who supplying the fruit and identify the growers who need special attention
- open communication with growers on specifications and requirements
- ensure growers have continuity of supply
- in-coming fruit inspection for maturity, rots, insects, bruises, and any other undesirable characters
- assess insect infestation and diseased fruit
- careful handling practice from the farm to the packinghouse
- careful handling at every stage of the packinghouse process regarding quality and safety
- washing water source, water quality and management
- effective postharvest treatment
- proper grading, sizing and packing
- good packaging, appropriate labeling, presentation, packaging and labeling requirements as specified by the importing country
- understanding and monitoring fruit behaviour during storage, ripening, and shelf-life test

Transportation:

- workers should practice good personal hygiene and sanitation practice
- avoid excessive handling/mishandling

- evaluation mode of transport to destined markets
- container loading check list check for cleanliness, odors, dirt microbial contamination
- maintain and monitor proper temperature
- use good quality containers, ensure shipper's reliability in providing export transportation service and cost
- on-time delivery to the customer
- export documentation (bill of landing, invoice, proof of origin and phytosanitary certificate if applicable) to facilitate rapid clearance at the importing port
- reduced customer complaints and initiate preventative/corrective actions

Record keeping requirements:

- good manufacturing practice manual
- valid quality plan
- Record keeping of packinghouse activities

For the regulatory authorities

Quality Goals:

- understand the dynamic changing market scene
- understand the legal and regulatory requirements of the importing countries and implications
- streamline regulations and procedures
- good governance
- providing effective and efficient information/technical services

Quality Parameters and Key Indicators:

- qualified, well trained and informed staff
- user friendly environment and personnel
- available data base on rules and regulations on import/export
- information on packaging and labeling requirements as specified by the importing country
- information /data base on international standards and requirements
- efficient up-to date information systems and easy and friendly access of information by users
- simple and easy administrative processes
- ensure the availability, speedy and competence services
- provision of inspection service to ensure chemical residues not exceeding Maximum Residue Levels or as specified by the importing country
- provision of inspection service to ensure conform to sanitary and phytosanitary requirements
- provision of chemical analytical services
- initiate/monitoring of consumer feedback

Conclusion:

The paper provided a comprehensive groundwork to the understanding of unique characteristics of durian and key features of fresh produce packinghouse operation. The coverage of topics starts from basic postharvest physiology of the fruit, quality variables along the handling chain, the choice and decision of the quality system to be used, a simple documented quality plan for packinghouse operation for durian and checklist for self assessment. They are hoped to be able to assist growers and packinghouse operators in initiating a quality assurance system that is practical and suited to the export of fresh produce under Thai conditions.

Table 1. Example of a Format For a First Tier Quality Plan of a Fresh Produce Exporting Operation

Originated by _____
 Approved by _____
 Date of issue _____
 Revision & date _____

Export Operation										
Grower/ Supplier Traceability	Sales	Management Planning	Design/ Development	Purchasing Plan	Inspection & Treatment	Material Control	Installation/ Service/ Delivery	Quality Assurance	Customer/ consumer requirements	Regulatory authority requirements
Grower/ supplier identification	Review of basic customer requirements	Contract planned	Design of process and production facilities	Purchase control plan	Fruit receiving	Stocking, storage, packing, transport, delivery	Equipment installation	Witness /shelf-life test	Produce specifications	Legislative/ regulatory requirements of destination countries
Produce quality, safety, liability agreement	Sale record	Input/output development plan	Design of product features and functions and meet or compare with standards/ specifications	Grower/supplier development plan	Purchasing and fruit inspection		Equipment servicing	Review of fruit inspection record	Consumer market research/bench marking	Information gathering
Farm quality plan & farm visit		Resource management & staff training			Fruit cleaning		Phytosanitary certificate when needed	Review of postharvest treatment record	Indicators for quality levels; Consumer feedback such as statements, dissatisfaction, complaints, claims, decreasing/ increasing sales	
		Management review	Grower/supplier development plan		Postharvest treatment		Exporting document	Review of material control record	Behaviour of competition companies	
					Grading and packing			Review of installation/ servicing record		
								Review of delivery record		

Table 2. Example of a format of a second tier quality plan for “Inspection and Treatment” of durian packinghouse operation

Process step (CP orCCP)	Description of activity	Procedure	Quality characteristics to be controlled	Process control measures	By whom
S1 (CCP) S2 (CCP) S3 (CCP)	Purchasing and inspection of incoming fruit	Procedure for receiving, inspection and grading of incoming fruit	• Grower/supplier identification and approved lists • Conform to durian standards/specification • Define critical safety parameters • Pesticide residue • Sanitation and microbial contamination • Define critical quality parameters • External fruit appearance • Internal fruit quality • Diseases • Insects	• approved supplier lists, ID, code, bar code no., tag • demonstrated preventive field precautionary measures • durian quality chart, voluntary durian standards or buyer’s specifications must be available and at display • grower/supplier agreement statement • residue report from competent authority • good farm and packinghouse sanitation practice • inspection of fruit: var. discard odd sized and shape, immature or over-ripe, diseased, insect infested, bruised or cut • use of inspection tools, subjective indicators, rind colour • for internal aril quality, random check or when in doubt, check aril colour and sweetness • short term stocking at the packinghouse • witness/shelf-life test	
S4 (CP)	Weighing of fruit		Weight of fruit in bin for each individual supplier Estimate number of fruit	• form for recording weight of daily incoming fruit	

S5 (CP)	Labeling of fruit		Labeling with a sticker or tag of individual fruit on the peduncle	• visual check for labels • form for total number of daily incoming fruit (optional)	
S6 (CCP)	Fruit cleaning	Procedure for cleaning or pre-washing	• reduce dirt or organic matters into subsequent dip tank When washing is to be carried out, ensure • clean water meet microbial standards • add chlorine or disinfect water with ozone, UV, chlorine dioxide, trisodium phosphate, or organic acids • routine inspection, maintenance, cleaning of washing tank • filtering recirculating water • hygienic working personnel, equipment, and environment	• visual examination • microbial test for water as necessary, change water as necessary • total chlorine at 50-200 ppm, pH 6.0-7.5 for 1-2 min or other chemicals as specified • service record sheet • water pump • good hygienic practice • cleaning working areas at the end of each day • visual inspection	
S7 (CCP)	Postharvest treatment	Procedure for antimicrobial chemical treatment	• use approved fungicides to limit decay strictly in accordance with the label instructions and health and safety regulations • chemical mixing and preparation • routine monitoring and record of chemical levels • inspection and maintenance of treatment tank • consider additional sanitizing dip to limit decay • consider chemicals for accelerate uniformed ripening • removal of field heat	• chemical safety data sheet • read label and method of application • record in chemical usage lot • use check sheet or form for concentration, pH, water level, temperature, dipping time, packout / batch or day • service record sheet • access to postharvest information, training or seek advice • obtain customer feedback information	
		Procedure for additional treatment			