Expert Consultation Meeting on Postharvest and Value Addition of Horticultural Produce

'Strengthening Technologies for Linking Farmers to Market'

Marriott Hotel, Putrajaya, Malaysia
29 November – 2 December, 2010

PROCEEDINGS AND RECOMMENDATIONS

Organized by
Asia-Pacific Association of Agricultural Research Institutions (APAARI)
Malaysian Agricultural Research and Development Institute (MARDI)

Co-sponsored by
Food and Agricultural Organization of the United Nations (FAO)
Global Forum on Agricultural Research (GFAR)
Horticulture Collaborative Research Support Program (HortCRSP)
Malaysian AgriFood Corporation (MAFC)

Supported by
Ministry of Agriculture and Agro-based Industry, Malaysia (MOA)

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'Strengthening Technologies for Linking Farmers to Market'

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Foreword

The Asia-Pacific region accounts for 57% of the world's total population and 73% of its agricultural population. About 80% of the world's small and marginal farmers live in this region which currently faces the challenge of liberating itself from growing hunger and poverty, the major objective of the Millennium Development Goals (MDGs). APAARI through its multifarious activities has been addressing diverse concerns related to agricultural R&D in the region focusing on food security, poverty alleviation, and agricultural and environmental sustainability. During a research prioritization exercise undertaken by APAARI, postharvest sector was recognized as one of the important areas requiring attention. In view of this, APAARI in collaboration with MARDI organized an expert consultation meeting on "Postharvest and Value Addition of Horticultural Produce" in Malaysia on 29 November - 2 December 2010.

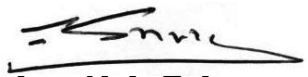
Horticulture plays an important role both for nutritional and economic security. The diversity of agro-ecologies across the Asia-Pacific region provides ideal environment for cultivation of a wide range of horticultural crops and has a vast potential for inter-regional trade. However, horticultural produce currently suffers an estimated postharvest loss of 30-50% which occurs due to poor preproduction and postharvest management as well as lack of appropriate processing and marketing facilities. The need for preventing such losses through on-farm and off-farm technological interventions need to be duly emphasized.

We are happy that this expert consultation attracted a galaxy of experts, growers and other organizations and individuals having a stake in postharvest of fruits, vegetables, herbs and ornamentals. It provided an opportunity to highlight recent R&D advances, field level experiences and issues confronting particularly the small holder farmers. The various presentations reflected the relatively weak status of postharvest and value addition in the Asia-Pacific and also the wide differences in the adoption of postharvest practices among the countries. It was, however, evident that postharvest and value addition are integral components of strategies to improve agricultural productivity and linkages between farmers and markets which will help contribute to food security and economic development.

We are pleased that the meeting deliberated on several postharvest related constraints and identified priority areas for research on improving need-based postharvest infrastructure, food quality and safety standards, supply chain, storage, processing and waste utilization, farmer-market linkages, distribution systems, value-addition and low cost technology suited to small farm holdings. The recommendation to establish regional Integrated Post Harvest Management Centers for technology dissemination and capacity building is highly relevant and needs to be followed-up at appropriate national levels.

It is envisaged that the recommendations of this expert consultation will help in developing national programs and regional collaborations in postharvest and value addition of horticultural produce for the benefit of all stakeholders. We thank NARS members, CG Centers, other regional organizations, NGOs and farmer groups, special invitees and experts for their active participation and significant contributions which helped to make this meeting a real success. Thanks are also due to GFAR, FAO, HortCRSP, MAFC, and AUUP for their support in organizing this important event. We are confident that his publication will be useful to the researchers, policy makers, entrepreneurs, farmers and other stakeholders.

Dr. Raj Paroda
Executive Secretary
APAARI



Datuk Dr. Abd. Shukor Abd. Rahman
Director General
MARDI

ACRONYMS and ABBREVIATIONS

AARI	Ayub Agricultural Research Institute (Pakistan)
AEC	ASEAN Economic Community
AMCL	Agricultural Marketing Company Limited (Bangladesh)
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology
APEDA	Agricultural and Processing Food Products Export Development Authority (India)
ARD	Agricultural Research for Development
ARS	Agricultural Research Station
ASEAN	Association of South East Asian Nations
AUUP	Amity University, Uttar Pradesh (India)
BARC	Bangladesh Agricultural Research Council
BNPP	Bhutan National Potato Project
BSTI	Bangladesh Standards and Testing Institution
CARP	Sri Lankan Council of Agricultural Research Policy
CCN	Cold Chain Network Sdn Bhd (Malaysia)
CFTRI	Central Food Technological Research Institute (India)
CIPHET	Central Institute of Post-Harvest Engineering & Technology (India)
CSIR	Council of Scientific and Industrial Research (India)
DFRL	Defense Food Research Laboratory (India)
DOA	Department of Agriculture (Sri Lanka)
FAO	Food and Agriculture Organization of the United Nations
FAO-RAP	Food and Agriculture Organization – Regional Office for Asia and the Pacific
GAP	Good Agricultural Practices
GFAR	Global Forum on Agricultural Research
GHP	Good Hygiene Practices
GMP	Good Manufacturing Practices
HACCP	Hazard Analysis Critical Control Point

HORDI	Horticultural Crop Research and Development Institute (Sri Lanka)
HortCRSP	Horticulture Collaborative Research Support Program (USA)
HRS	Horticultural Research Station, Bhutan
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICT	Information and Communication Technology
IPHM	Integrated Post Harvest Management
IPHT	Institute of Post Harvest Technology (Sri Lanka)
IPHMC	Integrated Post Harvest Management Centre
MAFC	Malaysian AgriFood Corporation Berhad
MAHA	Malaysia Agriculture Horticulture and Agrotourism
MARDI	Malaysian Agricultural Research and Development Institute
MAEPS	Malaysian Agro Exposition Park Serdang
MFPI	Ministry of Food Processing Industries (Malaysia)
MINFAL	Ministry of Food, Agricultural and Livestock (Pakistan)
MOA	Ministry of Agriculture and Agro-based Industry
NARC	Nepal Agricultural Research Council
NARS	National Agricultural Research System
NGOs	Non-Governmental Organizations
NHB	National Horticulture Board (India)
NIAB	Nuclear Institute of Agriculture and Biology (Pakistan)
NIFA	Nuclear Institute of Food and Agriculture (Pakistan)
PARC	Pakistan Agricultural Research Council
PCSIR	Pakistan Council of Scientific and Industrial Research
PHDEC	Pakistan Horticulture Development & Export Board
PHT	Post-Harvest Technology
PICTs	Pacific Island Countries and Territories
R&D	Research and Development
SAARC	South Asian Association Regional Corporation
SPS	Sanitary and Phyto-Sanitary Standards

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Background

Horticultural crops have an important place in the agricultural economy of the Asia-Pacific countries. The region grows a large variety of horticultural crops that collectively constitute more than half of the total world production. In addition, most of these countries have for the past several years maintained positive growth in production indicating the increasing role that horticultural crops play in enhancing farmer incomes, alleviating poverty and improving quality of diet. It is expected that the demand for both fresh and processed horticultural produce will continue to expand in line with the rise in per capita income, better standards of living and increasing awareness of their health benefits. The diversity of agro-ecological conditions and climates across the region provides an ideal environment not only for cultivation of a wide range of horticultural crops but also a vast potential for inter-regional trade and industry. Asia and Pacific countries have also abundant availability of indigenous fruits, vegetables and flowers many of which are known for their therapeutic/medicinal and nutritive value and excellent flavor and color. The demand for such produce is likely to increase in the international market both in fresh and processed form.

However, fresh horticultural produce is highly perishable with some estimates suggesting a postharvest loss of between 30-50% in fruits and vegetables. The losses are due to poor pre-production and postharvest management as well as lack of appropriate processing and marketing facilities. These losses have several adverse impacts on farmer's income, consumer prices and nutritional quality of the produce. Prices of seasonal horticultural crops fluctuate greatly and during the period of maximum availability the prices are not remunerative to the farmer. At other times these commodities are so highly priced that the ordinary consumers find them beyond their purchasing power. Another problem is that fruits and vegetables are not uniformly available and some areas suffer from inadequate supply even when there is a glut in other parts. At present there is considerable gap between the gross production and net availability of fruits and vegetables due to heavy postharvest losses. Attention to the concept of postharvest food loss reduction as a significant means to increase food availability was drawn by the World Food Conference held in Rome in 1974. The 7th session of the U.N. General Assembly in 1975 passed a resolution calling for 50% reduction of postharvest losses by 1985. Food loss prevention became a priority area with the FAO.

Some of the constraints to proper postharvest management in developing countries are: inadequate information and skills in harvesting and postharvest handling, lack of appropriate and low-cost

infrastructure, high transportation costs, poor access of farmers to markets and integration of marketing channels, poorly developed processing sector, non-utilization of horticultural waste, unfavorable policy support and inadequate investment in R&D. Small farmers with limited access to markets as well as financial resources are discouraged from adopting improved postharvest management techniques. About 80% of the world's small and marginal farmers live in the Asia-Pacific region; therefore, there is a need to identify constraints particularly affecting them, develop suitable strategies for overcoming the constraints, and identify areas of regional and sub-regional cooperation to facilitate sharing of information, resources and produce for the benefit of farmers and consumers. Besides, there is a need to share success stories of postharvest management in the region that can serve as models for other countries.

In view of these developments an "Expert Consultation on Postharvest and Value Addition of Horticultural Produce" was jointly organized by APAARI and MARDI in Malaysia on 29 November-2 December 2010. The meeting was co-sponsored by GFAR, FAO, HortCRSP, MAFC and supported by MOA. The objectives of the meeting were to:

- Review the current status of research, development and adoption of postharvest management and value addition of horticultural produce in the Asia-Pacific region.
- Highlight the latest technologies on postharvest, value addition, food safety and information management with emphasis on low cost technologies for small farmers.
- Explore the available information on success stories and replicable models on low cost technologies.
- Identify strategies for promoting linkages between farmers, markets and processors including public-private participation.
- Develop a regional action plan for strengthening cooperation in postharvest and value addition technologies, policy framework, and advocacy.

Session 1: Status of agricultural research development (ARD) initiatives on postharvest and value addition of horticultural produce in the Asia-Pacific Region

Chairperson: Dr. J.L. Karihaloo, Coordinator, Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), APAARI.

Status of ARD initiatives on postharvest and value addition of horticultural produce in South Asian Region, Prof. Dr. Nadeem Akhtar Abbasi, PMAS-Arid Agriculture University, Rawalpindi, Pakistan.

South Asia has been bestowed with diverse agro-climatic conditions ranging from true tropical to temperate, hence the region produces a wide range of agricultural commodities, especially the horticultural crops. The major agricultural R&D remains focused on increased production to feed the large population of this region while the postharvest arena has been largely neglected. Supply and cool chain infrastructure and storage facilities are at their infancy. The estimated postharvest losses range between 40% and 60%, varying from crop to crop and region to region.

However, more recently attention towards R&D on postharvest and value addition of horticultural products has been increasing. Several organizations are now involved in postharvest and value

addition of horticultural produce including ICAR, CSIR, NHB, APEDA, CIPHET, DFRL, MFPI, CFTRI and IARI in India; NARC, PARC, MINFAL, NIAB, AARI, NIFA, PCSIR and PHDEC in Pakistan; BARC, AMCL and BSTI in Bangladesh; HORDI, DOA, NARS, CARP and IPHT in Sri Lanka; HRS and BNPP in Bhutan, and NARC and ARS in Nepal. Agriculture is also under the agreed areas of cooperation of SAARC and joint actions have been undertaken to boost horticultural growth focusing postharvest and processing aspects.

Value addition of horticultural commodities requires a strong postharvest support. Some initiatives in this direction include establishment of research centres and cooperative institutes for development, demonstration and transfer of technology to the stakeholders. The various measures adopted include development of infrastructure like farm to market roads, storage facilities, cool supply chain, cargo and shipment convenience, marketing and export documentation. These steps including Global GAP and HACCP have to some extent helped to improve and maintain quality of horticultural produce. Grades and standards have also been introduced to compete in international market.

Status of ARD initiatives on postharvest and value addition of horticultural produce in Southeast Asia, Dr. Saipin Maneepun, Institute of Food Research and Product Development, Kasetsart University, Thailand.

Southeast Asia has been known as the centre of origin for a number of cultivated tropical fruit trees. The region possesses a variety of tropical fruits and is unrivalled in terms of the variety of fruit genetic resources. In 2009, the production of tropical fresh fruits from the region was about 22% of world production and 30% of Asian production. Thailand, Malaysia and Indonesia rank among the world's top 10 exporting countries. However, during 2005-9, the region had the average growth of tropical fresh fruits, vegetables and spices of only 0.65%, 1.06% and 12.67%, respectively. Despite the natural advantages the region has in terms of variety and production scale, there is a need to address the constraints to production and market access of the produce. Various herbs are being used to add flavour and/or aroma to food and beverages and for medicinal herbs. There is a need for more investigations to obtain a high productivity of quality products. Floricultural needs more attention; presently only orchids are the popular cut flowers for export from Southeast Asian region.

R&D needs to focus on the horticultural value chain that comprises various parameters and factors being specific and relevant to geographical area or ecoregion. Several countries in the region have developed and implemented GAP for on-farm productions and post-production processes to meet the current requirements on food safety. The ASEAN countries has agreed to establish ASEAN Economic Community (AEC) for regional economic integration in order to enhance intra- and inter ASEAN trade and long term competitiveness of ASEAN food and agricultural commodities/products. AEC has proposed a regional strategy to facilitate the implementation of ASEAN GAP for fresh fruits and vegetables. The scope of ASEAN GAP covers the production, harvesting and postharvest handling of fresh fruits and vegetables on farm and postharvest handling in locations where produce is packed for sale.

AEC has identified the targets and timelines for implementation of various measures for GAP, GHP, GMP and HACCP based systems for agricultural and food products with significant trade and trade potential by 2012. Also, it has been suggested to harmonize the safety and quality standards for horticultural produce and agricultural products of economic importance in the

ASEAN region, in accordance with international standards/guidelines by 2015, especially for single market and production base.

Studies and extension on precooling technology of horticultural crops in Taiwan, Dr. Lin Doung-Liang, Tainan District Agriculture Research and Extension Station, Council of Agriculture, Chinese Taipei.

Postharvest temperature management for horticultural crops is a common practice in Taiwan. The transfer of technology and information on cooling technology to farmer in Taiwan started in 1990. As a result of the 20 years of government sponsored projects, forced-air cooling, hydrocooling and vacuum cooling facilities have been constructed on most farmers' shipping terminals. Precooling process has become an essential procedure. As a result, both producers and consumers have benefited from the high quality produce.

Status of ARD initiatives on postharvest and value addition of horticultural produce in the Pacific Region, Dr. Surya Nath, Dr. Anton Mais and Dr. Raghunath Ghodake, National Agricultural Research Institute, Papua New Guinea.

Almost all the 22 Pacific Island Countries and Territories (PICTs) with an estimated population of about 9 million, grow a variety of horticultural crops. These crops include banana and plantain, taro, sweet potato, cassava, yams, mango, citrus, pineapple, coconut, pandanus, bread fruit, canarium nut, okari nut and leafy vegetables such as aibika, amaranth and others. The production practices are usually indigenous and produce are organic in quality. The vast majority of these produce are bulky and perishable and are consumed at the farm family level, thus forming the basic source of food, nutrition and overall livelihood. A modest amount of produce is marketed domestically. However, there is a huge scope for export of primary produce as well as processed products like juices, jams, canned fruits and vegetables. This can earn much needed foreign exchange and generate employment from the horticulture sector in the Pacific region.

Only a limited amount of work has gone into PHT R&D, particularly on transportation, storage, packaging and marketing, with very little work on value addition, especially through processing. This is attributed to the lack of research capacity, entrepreneurship, facilities, infrastructure, investment, congenial policies and comparative and competitive advantages. The presentation also detailed the future prospects and strategic considerations, especially in networking, partnership and innovativeness in developing the options of postharvest and value addition in the horticultural industry. It is hoped that with innovative R&D, favourable policies and entrepreneurship, this potential could be exploited for the benefit and prosperity of the Pacific region.

Recent ARD achievements on postharvest and value addition of horticultural produce in Malaysia, Mr. Abdullah Hassan and Ms. Hasimah Hafiz Ahmad, Malaysian Agricultural Research and Development Institute (MARDI), Malaysia.

The horticultural industry plays an important role in socio-economic development of Malaysia. Besides production and marketing factors, the sustainability of Malaysian horticultural industry is highly influenced by the availability of postharvest handling and value addition technologies. Postharvest handling includes harvesting, packinghouse operations, grading, packaging, storage, transportation, ripening and disease control. While the earlier R&D activities on postharvest development were targeted mainly at reducing postharvest losses, the current activities are focused towards supplying safer and better quality produce for the market either domestically

or for export through the development of complete handling technologies. Many improvements and achievements have been made in this area including further extension of storage life, non-destructive technique for internal quality determination, suitable physical and chemical treatments for quality maintenance, and minimal processing and shipment trials to new markets. Research activities on value addition for food consumption have been conducted on various fruits, vegetables and herbs with the objective of introducing new technologies to the local food industry, improving existing technologies, obtaining new information, improving productivity in production and diversifying the range of products in the Malaysian market. Improvements on specific postharvest and processing quality have also been made through agronomic practices and breeding programs. New technologies are promoted for uptake by the local industries. There is good cooperation among the research organizations with relevant government agencies and private sector, both locally and internationally.

The salient points that emerged during discussion on the above five papers were:

- Need to focus on establishment of research institutes and cooperative centers for development, demonstration and transfer of technology to the stakeholders.
- Development of infrastructure like farm to market roads, storage facilities, efficient supply chain, cargo and shipment convenience, and marketing and export documentation.
- Implementation of various measures for GAP, GHP, GMP and HACCP based systems for agricultural and food products and harmonization of the safety and quality standards for horticultural produce.
- Postharvest temperature management particularly pre-cooling process for high quality horticultural produce.
- National and international public-private partnership to be encouraged to improve postharvest and processing quality and introduce new technologies, and diversify the range of processed products.
- Innovative R&D, favorable policies and entrepreneurship to be adopted for the benefit and prosperity of the region.

Session 2: Technology spectrum for managing quality and safety of horticultural produce

Chairperson: Dato' Dr. Sharif Haron, Deputy Director General (Research), MARDI, Malaysia.

Horticulture CRSP, a long term commitment by USAID to address poverty and hunger of the rural poor in Developing Countries, Prof. Dr. Robert E. Paull, Dr. R. Voss, Dr. E. Mitcham, Dr. M. Reid, Dr. M. Bell, University of Hawaii at Manoa and University of California, Davis, USA.

The Horticulture Collaborative Research Support Program (HortCRSP) was initiated in 2010 with the selection of UC Davis to manage this 10-year research, outreach and development program that partners U.S. public universities with organizations, institutions, agencies, and other groups in developing countries. Focus areas are sub-Saharan Africa, South and Southeast Asia, and the poorest regions of Latin America, with particular focus on countries focused on by the USAID Feed the Future Initiative. The goals of HortCRSP are to reduce poverty, improve

human nutrition and health, and enhance sustainability and profitability through horticultural crop production and marketing. Priority objectives include sustainable crop production, improvement and availability of germplasm and seed, and improved postharvest technology, food safety, market access, financing, diversification of income, and economic and social conditions of the rural poor, particularly women. Themes, which will be characteristic of all activities of HortCRSP, include Information Accessibility, Technology Innovation, and Gender Equity. Postharvest technology is viewed as a critical factor for effective marketing of horticultural crops. Horticulture CRSP has funded several projects related to postharvest technology including developing a concentrated solar dryer, low cost cold room technology using portable room air conditioners, and a small scale seed storage system using zeolite materials. In addition, a postharvest training and services center model will be piloted in Rwanda as one of the new three-year pilot projects.

Capacity building in support of horticultural chain management in Asia and the Pacific - FAO's initiatives and activities, Dr. Rosa Rolle, FAO Regional Office for Asia and the Pacific (FAO-RAP), Bangkok, Thailand.

The paper presented a brief historical profile of FAO's work on postharvest. It described FAO's activities and initiatives across the region designed to build a culture of good practices in the region's fruit and vegetable sector.

Fruits and vegetables make a substantial contribution to food and nutrition security, to poverty alleviation and to enhancing farmer income in Asia and the Pacific region. Fruit and vegetable production continues to show a growth trend across the region. FAO's statistics show an annual growth rate of 3.3% for fruit over the period 1996 to 2006 while the annual growth rate for vegetable production was 4.9% during that period. Fruit and vegetable consumption is also increasing across the region and this growth trend is likely to continue with increasing consumer awareness of the health benefit of fruits and vegetables, growing consumer preferences for healthy lifestyles and increasing incomes.

Postharvest losses in fruits and vegetables across the region, however, continue to pose a problem owing to poor postharvest management and inefficient marketing systems. These constraints adversely affect the quantity and quality of produce available for consumption as well as farmer incomes and consumer prices. The safety of the region's fresh produce outputs is also a major issue of concern for national, regional and international markets.

A number of consultations conducted by FAO in collaboration with GFAR, through APAARI across the region during the early part of this decade highlighted the need for capacity development to upgrade fruit and vegetable postharvest systems to address safety and quality and to reduce losses. FAO has responded to this need by partnering with renowned institutions in the region, to develop and to tailor Training of Trainer Programs to the needs of the region. These programs are team taught by specialists from the region and private sector partners, and have been implemented across the region in collaboration with governments and academic institutions.

Low cost postharvest technology and value addition of fruits and vegetables for the benefit of small farmers of South Asia, Prof. Susanta K. Roy, Amity International Centre for Postharvest Technology & Cold Chain Management, Amity University Uttar Pradesh, India.

Small farmers are the back-bone of South Asian Agriculture in general and horticulture in particular. In India, about 80% farmers are small and the scenario is more or less the same

in most of the South Asian countries. The farmers face various postharvest related problems such as: i) no access to basic infrastructure for handling, packaging, storage, transportation, marketing and processing, ii) exploitation by middle men, iii) non-remunerative return during peak season, iv) frequent dependence on heavy debt, v) lack of appreciation of postharvest management and processing needs.

Most of the technologies and the commercial methods of postharvest processing are expensive and beyond the means of small farmers. Therefore, it is necessary to develop and adopt low cost technologies. At present, in most of the South Asian countries, fruits and vegetables are marketed immediately after harvesting without sorting which results in large amounts of unmarketable produce being sent to the market. Therefore, it is necessary to establish collection and sorting units for the benefit of small farmers. Such units at nodal points can link farmers with markets, fruits and vegetables handlers and processors.

A large amount of quality deterioration of horticultural produce takes place immediately after harvest due to lack of on-farm storage facilities for the small farmers. In order to overcome this problem, low cost environment-friendly cool chamber developed in India can be adopted. The maintenance of low temperature during transit and at different stages of handling process results in reduction of losses and retention of quality of fruits and vegetables and their products. Establishment of cool chain based on evaporative cooling will go a long way in improving the handling of fruits and vegetables in South Asia.

One of the reasons for the food processing industries based on fruit and vegetables not being very viable in South Asian countries is non-utilization of waste accumulated during handling and processing. This waste can also be gainfully utilized for making value added products. In addition, the problem of disposal of solid wastes from the food industry can be solved to a great extent.

This presentation also detailed some low cost storage, handling and processing techniques such as Zero Energy Cool Chamber (ZECC), solar drying, small scale processing, pickling, fermentation etc which can be easily adopted by small farmers. Adoption of Integrated Postharvest Management (IPHM) is advocated to utilize 100% of production in one form or another. In addition, awareness programs regarding food safety issues need to be promoted.

Simple, reliable and cost effective postharvest machineries for horticultural produce, Dr. R.T. Patil, Central Institute of Post Harvest Engineering and Technology, Ludhiana, India.

Post-production losses in horticultural crops are enormous due to their highly perishable nature. Post harvest losses take place due to farmers' small land holding, non availability of cold chain infrastructure and processing facilities in production catchments. The establishment of modern agro-processing industries requires appropriate and affordable cool storages and processing equipment and methods. The responsibility of developing suitable PH technologies for agricultural produce in India is on the Central Institute of Post Harvest Engineering and Technology and its All India Coordinated Projects spread over 38 centers. The equipment/machines developed for horticultural crops include non-destructive technique to determine maturity of mango on tree, hand tool and motorized unit for easy separation of arils from pomegranate, porous bricks for cool chamber, strawberry harvester cum holding tool, basket centrifuge for minimal processing of vegetables, fruit washers, evaporative cooled structures for storage of fruits and vegetables, banana cutter, fruit saver for safe harvesting and handling of fruits, mobile cool chamber

(Transportation Rickshaw) and a two stage evaporative cooler. The process protocols developed for horticultural crops include process for pomegranate jelly and granadine, process technology for *anardana* and its powder, process of manufacturing ready to constitute *makhana* (*Euryale ferox*) *kheer* and *sarson* (Mustard) ka *saag*, low cost technique for enhancement of shelf life of tomato, beet root powdering technology, minimal processing of fruits and vegetables, value added products from anola, pomegranate, ber (*Zizyphus mauritiana*) and guava. Based on these developments, entrepreneurship development programs and technology licenses are offered at CIPHET so that upcoming entrepreneurs can get hands on experience on modern technologies to establish businesses in postharvest sector of horticultural crops in production catchments.

Disinfectant electrolysed acidic water and other antimicrobial agents as food additives for fresh and fresh-cut produce, Prof. Dr. Hidemi Izumi, Department of Science and Technology on Food Safety, Faculty of Biology-Oriented Science and Technology, Kinki University, Wakayama, Japan.

Since microbiological control and safety are of major concern with fresh and fresh-cut produce, washing the produce is an important step to reduce microbial contamination. In addition to the use of sodium hypochlorite as a disinfectant, which can have an adverse effect, other chemical disinfectants and natural antimicrobial agents are promising. One of the disinfectants is electrolyzed acidic water, which was approved as a food additive by Ministry of Health, Labor, and Welfare of Japan in 2002. Electrolyzed acidic water includes electrolyzed strong acidic water (pH<2.7, 20-60 ppm available chlorine) and weak acidic water (pH 5-6.5, 10-30 ppm available chlorine). When the microbicidal effect of electrolyzed strong acidic and weak acidic water was compared on fresh-cut spinach, cucumber and carrots by rinsing, the reduction of bacterial counts of both electrolyzed water was similar and the count was 1 to 2 logs lower than tap water. Electrolyzed acidic water was more effective against Gram-positive bacteria than against Gram-negative bacteria. Ozonated water (5 and 10 ppm) also reduced the microbial counts by 1 log when compared with tap water and was more effective on fresh-cut cabbage than on lettuce. With the natural antimicrobial preservatives, 0.5% ferulic acid agent (2% of ferulic acid) or 1% fumaric acid agent (20% of fumaric acid) applied on fresh-cut lettuce, 0.1% mustard and hop extract agent (10% of allyl isothiocyanate and 7% of β-acid) on fresh-cut cabbage, and 0.05% calcined calcium agent (91% of calcium) on fresh-cut cucumber, treatments reduced the microbial counts by 0.3 to 1.5 logs relative to tap water-dipped control. The fumaric acid agent followed by electrolyzed water treatment was the most effective in reducing microbial counts with fresh-cut lettuce and cucumber. Therefore, effectiveness of a disinfectant and agent differs with produce and needs to be evaluated and defined accordingly.

Information management as an emerging postharvest technology issue for resource poor farmers (paper circulated, not presented), Dr. Ajit Maru and Dr. Divine Njie, FAO, Rome, Italy.

GAP is emerging as the basis for a regulatory framework the world over and more so for producing for organized markets of developed countries. GAP requires information management in production and on-farm postharvest handling. This information management includes maintaining auditable records of all inputs and farming and produce handling practices as well as the times at which they were carried out. Without appropriate information management, small holder farmers cannot record the required information and, hence, cannot produce for and participate in higher value, organized markets.

The labelling of agricultural and food products is essential for participation in organized markets such as those in developed countries. Access to these markets requires labels for agricultural produce to carry information on the brand and producer/manufacturer, stating content, quantity, quality, nutritional, food safety and price, in addition to the product having to comply with regulatory requirements including adherence to GAP. There is now an increasing requirement to inform on the "identity" of the product including its origin and the associated ability to trace this identity on the label or provide "traceability" which in turn can relate to adherence of GAP.

Traceability, depending on the regulatory mechanisms applied, requires that the product is traceable to its original production and/or processing site for product or process level tracing. Consequently traceability, as a part of a label for an agricultural product, also increases the cost of production and marketing. Labelling and information management costs are estimated at between 6-25 percent of the total product cost to the consumer. A major component of this cost is borne by farmers through lowered farm prices which reduce their incomes.

Many smallholder farmers and producers in developing countries are illiterate and lack appropriate tools, applications and skills to maintain and manage records. Further, primarily information management is a challenge to small producers as their production is usually aggregated either at the farm gate or the local market and record keeping and preserving "identity" at the producer level becomes difficult.

The key to addressing labelling issues and reducing costs of information management for small holder farmers and producers lies in appropriately aggregating their products and in using information and communications technology (ICT). Aggregation of smallholder farmers can be at actual farmer, farm, field and product level. Using ICTs, this can be done through appropriate database technology coupled with Geographical information Systems and identification devices such as bar codes and Radio Frequency Identity Devices (RFIDs). Along with, several institutional frameworks including those related to cooperative agricultural production and marketing need to be revisited.

During discussion on the presentations in this session, the following key points emerged:

- The main aim of PHT technology in developing countries is to reduce poverty, improve human nutrition and health and enhance sustainability and profitability through horticultural crop production.
- Emphasis to be given on postharvest training and services center model.
- Simple, reliable and low cost storage, handling and processing techniques such as ZECC, solar drying to be promoted among the farmers.
- Need to upgrade fruit and vegetable postharvest system to address safety and quality issues and reduce losses.
- Adoption of Integrated Postharvest Management (IPHM) is advocated to utilize 100% of production in one form or another.
- Capacity development to upgrade fruit and vegetable postharvest systems and to tailor Training of Trainer Programs to the needs of the region. This can be achieved by partnering with renowned institutions in the region.

Opening Ceremony

Chief Guest: YB. Dato' Wira Mohd. Johari Baharom, The Honourable Deputy Minister of Agriculture and Agro-based Industry, Malaysia.

Dr. J. L. Karihaloo welcomed the Chief Guest and all the participants on behalf of APAARI. He appreciated the overwhelming response to the invitations for participation in the expert consultation meeting and thanked the co-organizers and co-sponsors for their support. He specially thanked Datuk Dr. Abd Shukor Abd Rahman, Director General, MARDI, and Chairman, APAARI for hosting and co-organizing the expert consultation meeting. He mentioned that following the expert consultation on Agricultural Biotechnology held in 2008, this was the second APAARI meeting being hosted by MARDI in recent years. Dr. Karihaloo expressed his gratitude to YB. Dato' Wira Mohd. Johari Baharom, The Honourable Deputy Minister of Agriculture and Agro-based Industry for agreeing to address the opening session. Dr. Karihaloo briefly highlighted APAARI's achievements as a regional neutral forum and the impact of the expert consultations it has organized earlier to address a wide range of ARD issues for the benefit of NARS in the Asia-Pacific region. He hoped that the deliberations of this meeting would lead to an effective action plan for improved postharvest management and an increase in regional cooperation which would benefit both farmers and consumers.

In his welcome address, Datuk Dr. Abd. Shukor Abd. Rahman expressed appreciation of APAARI in organizing the expert consultation meeting in Malaysia which, in his opinion, was a timely initiative emphasizing postharvest technology and processing as key drivers for agriculture sector. He highlighted that MARDI has an R&D mandate to develop competitive technologies in agriculture and food. He also indicated that MARDI has further enhanced the pace and efficiency of postharvest and value addition R&D by fostering local and international linkages in both developed and developing countries. In Malaysia, the relevant R&D institutions have a common objective of enhancing scientific discovery and developing innovation towards transforming the country into a postharvest and value addition R&D hub. Datuk Dr. Abd. Shukor thanked YB. Dato' Wira Mohd. Johari Baharom, for his continuous support and guidance in MARDI's programs and activities, including the organization of this meeting. He expressed his thanks to sponsors, consultants, speakers and participants for their contributions and support in making this meeting a success.

YB. Dato' Wira Mohd. Johari Baharom, in his opening address welcomed the guests, consultants, speakers and participants and congratulated APAARI and MARDI for organising this important expert consultation meeting. He wished the meeting every success. The Honourable Minister mentioned that horticultural industry plays an important role in the economic development of many countries. However, most horticultural produce is highly perishable and the postharvest losses in most developing countries including those in the Asia-Pacific region are generally high. Improper production techniques and poor postharvest handling practices also affect the safety of produce. Thus, the development of low cost and effective methods and simple postharvest handling facilities are essential for successful adoption by the developing nations. He emphasized that postharvest and value addition have significant role to play in poverty alleviation and malnutrition reduction by enhancing effective usage of food production. He spoke about the efforts of the Malaysian government to improve the supply chain for the benefit of the farmers and consumers. The Honourable Minister expressed confidence that the present expert meeting would come out with useful guidelines for policy makers and researchers to spearhead the development of the Asia-Pacific region.

Session 3: Initiatives and experiences of farmers and farmer organizations on PHT of horticultural produce

Chairperson: Prof. Susanta K. Roy, Amity International Centre for Post Harvest Technology and Cold Chain Management, Amity University Uttar Pradesh, India.

Processing of essential oils from herbs – from R&D to pre-commercialisation, Mr. Ahmad Ab. Wahab, MARDI, Malaysia.

The processing of essential oils involves activities such as harvesting, drying, chopping, extraction, quality assessments and packaging. The essential oil herbs that have been studied are tea-tree (*Melaleuca alternifolia*), patchouli (*Pogostemon cablin*), kesum (*Polygonum minus*), basil (*Ocimum basilicum*), Limau purut (*Citrus hystrix*), lemon grass (*Cymbopogon citratus*) and citronella (*Cymbopogon nardus*). Various distillation techniques had been studied such as wet steam distillation, fairly dry steam distillation and high pressure steam distillation. MARDI has developed three prototype distillation systems to cater for small scale farmers and large scale essential oil producers. The quality assessment of essential oils has also been carried out based on International and Malaysian standards. Studies on up-scaling of essential oil farms, postharvest techniques and distillation have been carried out with the objectives of obtaining efficient postharvest handling, maximum oil recovery and acceptable quality essential oils.

Postharvest and value addition of horticultural produce in Bangladesh: The experiences of farmers and farmer organizations on postharvest technologies, Dr. Md. Saleh Ahmed, National Agricultural Technology Project (NATP), Hortex Foundation, Bangladesh.

The presentation reviewed the existing postharvest handling practices, extent of postharvest losses between harvest and consumption and the present status of value addition in horticultural crops. The major constraints in postharvest handling management were outlined and suggestions made to mitigate the identified constraints.

The farmers are practicing postharvest operations with traditional methods of simple sorting and grading or washing the produce. Packaging in most cases is done in traditional ways using bamboo baskets and gunny bags. The use of modern postharvest technologies is minimal mainly due to lack of information about the low cost postharvest technologies, low levels of education and farming experience of the farmers and other participants in the supply chain. The paper highlighted the present status of quality assurance system in the horticultural supply chain along with the constraints that affect quality and safety of produce and recommended possible interventions to address the quality assurance issues. It outlined the existing postharvest handling and processing technologies that greatly influence the level of postharvest losses and value addition in horticultural crops.

The presentation also described the experience of the farmers/farmer groups who adopted postharvest technologies and collective marketing of their high value crops under the project implemented by the Government of Bangladesh in collaboration with NGOs who organized farmer groups and mobilized the farmers. The experience of farmers registered to grow and supply safe and good quality vegetables to satisfy the EUREPGAP/GlobalGAP requirement for export to European countries was stated. The recent initiatives undertaken by the Government with the support of development partners to reduce postharvest losses of horticultural produce and improve the sanitary and phytosanitary standards

was also detailed. Recommendations were made to ameliorate postharvest losses and address the issues related to produce quality and safety and value addition.

Storage and postharvesting technologies: a Himalayan initiative, Dr. Anil P. Joshi, Himalayan Environmental Studies and Conservation Organization, India.

In India, hardly 1.3 to 2.5% of fruit is processed while 30-40% turns waste every year because of lack of community training on postharvest management. Distress selling and wastage of produce have discouraged farmers and contributed to the current trend of fall in farmers' number. Farmers' access to storage and postharvest technologies is the most important challenge today. Four important issues need to be addressed immediately: development of pro-farmer postharvesting technologies, measures to increase farmers' access to postharvest technologies, farmers' network for storage and processing of produce and management, and development of marketing intelligence in the farmer communities.

The presentation highlighted some initiatives taken by the Himalayan farmers in India. Organized farmers communities have not only developed their network for product development but also networked for marketing. The paper presented strategies that need to be adopted in the overall interest of farmers and the rural community.

Initiatives and experiences of farmers and farmer organizations on PHT of horticultural produce in The Philippines, Prof. Amihan Jonos, Federation of Free Farmers, Philippines.

Banana is the leading fruit grown in the Philippines with an average annual production of 4.78 million tons. Backyard and small-hold farms cover 90% of the total banana farms. Most of the local produce is sold direct as fresh bananas like `lakaatan' and `latundan' and the green cooking bananas like `saba'. Besides, bananas are utilised for processed products such as chips, catsup, puree, powder, starch, wine and vinegar. A study of the postharvest practices followed by the farmers indicates the need to evolve and adopt good management system, proper postharvest facilities and training to adopt new technologies on postharvest of banana.

Initiatives and experiences of farmers and farmer organizations on PHT of horticultural produce in Malaysia, Mr. Ricky Y. K. Yong, Malaysia Fruit Exporters Association, Kuala Lumpur, Malaysia.

Malaysian Fruit Exporters Association comprises key fruit exporters engaged in the growing, selling and exporting of tropical fresh fruits to the global market. The association works closely with various ministries and agencies (FAMA, MARDI, DOA and SIRIM) to develop standards and increase exports. It also plays an active role in linking public and private sectors by highlighting issues and options to transform the agricultural sector. The exporters play a vital role in providing contract farmers latest preharvest and postharvest handling technologies and identifying fruits with export potential. They also work towards improvement in quality standard and food safety measures to ensure that the export produce meets international certification standards. The exporters also provide assistance to growers in the implementation of GAP and Global GAP certification.

The export of fresh produce to the overseas market is dependant on the quality of produce and sustainability of supply at a competitive price. The 5P's essential for export marketing of fresh fruits are: (i) Preharvest handling and treatment (ensure that the agroclimate is suitable for

the crop type; ensure proper drainage and irrigation system; regular supply and application of fertilizers, chemicals and fungicides within the minimum residue level); (ii) Postharvest handling and treatment (fruits are harvested in the correct manner and at appropriate maturity; harvested fruits are handled and transported with proper care and in good condition, washed, cleaned and sorted with stringent quality selection); (iii) Precooling (the fruits are transported from the farm to the packing house in a cold truck with good air flow ventilation; fruits are precooled at the correct temperature prior to storing in the cold room); (iv) Packaging (the packaging used is strong with good air flow and attractive design; the pallets used should meet international SPS standards and requirements; palletising of the boxes is firm and secured with good air flow and ventilation); (v) Price (identification of selected commodities with competitive advantage; the cost of products must be competitive in order to be marketable by adopting an efficient production strategy; maximise the loading of the container in order to benefit from lower transportation cost; ability to supply the market with sufficient quantity of the right produce at the right time and right price).

The key points that emerged during the ensuing discussion in this session were:

- Efficient distillation systems for extraction of essential oils have been developed to cater to small and large scale producers.
- Important strategies to reduce postharvest losses are: development of pro-farmer post harvest technologies, increasing farmers' access to technologies, farmers' network for storage and processing of produce and management, and development of market intelligence in the farmer communities.
- There is a lack of information about modern postharvest techniques among most farmers. Initiatives for product development and marketing will improve overall interest of farmers and the rural community.
- Need for farmers to adopt good management systems and storage facilities.
- Public and private sectors need to work together and address common issues and options to transform the agricultural sector.
- Role of contract farmers in identifying horticultural produce with export market potential needs to be recognized.
- The 5P's essential for export marketing of fresh horticultural produce are, Preharvest and Postharvest handling and treatment; Precooling; Packaging and Price.

Session 4: Global ARD future directions on postharvest and value addition of horticultural produce

Chairperson: Mr. Abdullah Hassan, Deputy Director, Horticulture Research Centre, MARDI, Malaysia.

Overview of future directions for ARD for postharvest and value addition of horticultural produce - fruits and vegetables, Prof. Dr. Robert E. Paull and Nancy Jung Chen, Tropical Plant & Soil Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, USA.

The future postharvest research needs of fruits and vegetables for agricultural development will be driven by the two major components of the postharvest chain: the wholesaler/retailer and the consumer. The criteria used by these two groups to evaluate postharvest research needs overlap, though the criteria have different priorities. The consumer wants a supply of high quality and safe fruits and vegetables at a low price while the wholesaler/retailer, mainly supermarkets, want a consistent supply of high quality safe produce. The wholesalers/retailers also want to reduce the number of suppliers and generally prefer frequent shipments to avoid unnecessary storage and have rapid stock turnover thereby reducing postharvest losses.

Quality aspects such as food safety, nutritional value and wholesomeness should be seen as adding value to a product, not a burden. Improved efficiencies in supply chain logistics, postharvest handling technology and management and the diverse sourcing of fruits and vegetables are being driven by consumer desires for quality products. The crucial element in postharvest handling is the need to boost and maintain quality and thereby assure maximum storage and shipping life. The definition of quality is also expanding as consumer concerns include nutritional value and wholesomeness. Frequently, technological changes in the handling of fresh commodities are slow to be accepted by shippers, wholesalers and retailers. Part of the hesitation lies in determining the economic advantage and the capital tied up in the current handling system and equipment. The lack of information as the reason for losses and relative importance of the causes (mechanical, physiological, pathological) contributes to the problem. The decision to implement a new technology needs to be based upon available evidence and common sense rather than strict logic. Researchers need to develop data that involves simulated shipping tests and commercial trials. In some cases, this will not allow for the different constraints experienced by growers and shippers. Supply chain logistics, postharvest technology management and diverse sourcing of fruits and vegetables have brought enhanced concern for food safety, another area of technology change that has become a crucial component of quality. All innovations and application of technology needed to ensure market access for growers and shippers should be integrated and optimized into the handling system.

Global ARD future directions on postharvest and value addition of floriculture - quality increase after harvest of cut flowers, Dr. Uulke Van Meeteran, Wageningen University, Dept. Plant Sciences, Horticultural Supply Chains Group, Wageningen, The Netherlands.

The cut flower market has become a globalized market. The site of production is often far away from the site of the final customer and the flowers are transported for long periods by truck, airplane or boat with high transport costs. Companies can attempt to maintain or enhance their market share by lowering the costs of production or transport. However, competing with others by the selling price will often result in production of a low priced bulk product. When perishable products have to be transported over long distances, as for example, cut flowers from Malaysia to Japan, the transport costs can even exceed the value of the flowers for low priced products. This can stimulate efforts to decrease the costs further including the transport costs. Cheaper ways of transport can cause loss of flower quality, which can result in a negative spiral of price and demand. A demonstration of this can be seen in the 50% decrease in consumption of cut flowers form 1993 till 2002 by consumers in the USA after the shift of the main suppliers from North to South America. Adding value to the product looks a better strategy.

As another result of the globalization of the flower market, producers and exporters have to compete with colleagues from all over the world. The quality should at least meet the 'average

global flower quality'. When we want to add value to cut flowers in the postharvest phase, we should look at the cut flower supply chain as a Value Chain in which products pass through all processes of the chain in order, and at each process to gain some value. This implies that the activities in the postharvest part of the supply chain should not only be focussed on the product itself but on the attributes that are valued by consumers of the product. To add value above the global minimum standard one should start with finding out what consumers want. In the UK, some retail chains increased their market share from 18 to 60% over 15 years by introducing a 'Vase Life Guarantee' and at the same time implementing measures to obtain a more uniform longer vase life of their flowers. At present, the carbon footprint of products, including cut flowers, becomes part of the attributes that are valued by consumers. Compared to transport by air, using sea container transport could dramatically decrease the CO_2 emission of the supply chain and in that way adds value to the flowers. Transport by ship, however, seems contradictory to the adage that the speed of distribution is a critical factor for vase life of cut flowers.

There have been rarely critical analyses to identify the principal sites of quality loss and their relative importance. Temperature is one of the most important factors in the postharvest phase; it affects physiological as well as physical processes involved in quality loss. Moreover, growth of pathogens like *Botrytis* and bacteria are affected by temperature. Handling, like sleeving, boxing, placing flowers in water during transport or keeping them dry, re-cutting of stems or not, will interact with some processes affected by temperature. The final effect of temperature (fluctuations) in the postharvest chain on flower quality will depend on the duration of the (links of the) chain. Due to the complexity, simulation models may be good tools to identify the critical points to prevent quality (vase life) loss in a particular postharvest chain. A tracking and tracing system, that includes monitoring of the environmental conditions and handling practices, can be an important instrument to improve postharvest conditions, especially when this system can be combined with a model that predicts the effects on vase life.

Although quality is largely affected by postharvest conditions, these conditions strongly interact with genotype and cultivation practices. Selection of the cultivar as well as conditions during cultivation is as important for postharvest quality as postharvest treatments.

Global ARD future direction on postharvest and value addition of herbs and medicinal Crops, Prof. Ramlan Abd. Aziz, Universiti Teknologi Malaysia (UTM), Malaysia.

Phytochemicals or plant-derived chemicals are natural products which are frequently being used as ingredients in foods, cosmetics, pharmaceuticals and other consumer products. SRI International in its recent report titled 'Spas and Global Wellness market: Synergies and Opportunities' stated that the current wellness industry has a value of USD1.9 trillion as people spending are shifting from illness oriented products, such as pharmaceuticals to wellness promoting products, such as herbs, medicinal plants and nutraceuticals. Also, increasing aging population, emphasis to control healthcare cost, and increasing awareness of side effect of synthetic drugs have become important drivers of this lucrative market. With all these scenarios plus the need to address the quality and regulatory issues of safety, efficacy and standardization of phytochemicals, scientists and engineers face continuous challenges to determine the most appropriate scientific methodologies in postharvest, manufacturing processes or process technologies, and product formulations to produce the desired results. These scenarios offer great opportunities to phytochemical industry in Asia-Pacific to market its unique phytochemical assets in the form of semi-finished products

(e.g. fine chemicals or active pharmaceutical ingredients) or finished products (e.g. specialty chemicals or final formulations). However, to achieve these objectives, appropriate investment is needed in focus research areas and human resources that specialize in all areas of the herbal value chain, e.g. in postharvest methods, processing and purification technology in order to meet downstream product formulation industry (phytomedicines, nutraceuticals, biopharmaceuticals, flavors and perfumes, etc.) requirements. As standardization is an important aspect in increasing the added value especially in phytomedicine production, processing technology innovation as well as optimum process operating conditions are required when processing herbs and medicinal plants.

Global ARD future direction on value addition of fruits and vegetables, Prof. Dr. Aminah Abdullah, Universiti Kebangsaan Malaysia (UKM), Malaysia.

Fruits and vegetables are very important component of food needed to maintain good health. The dietary guidelines of most countries recommend an intake of two servings of fruits and three serving vegetables every day. Fruits and vegetables are considered to be protective foods containing vitamins, minerals, fibres and oxidants. Epidemological studies indicated that fruits and vegetables intake will lower the risk of coronary heart disease, hypertension and stroke and may prevent cancer and slow down the process of aging as well as overcome obesity. Therefore, it is important to add value to fruits and vegetables during growing, at postharvest stage and during processing. Fruits sometime are no longer safe due to the presence of pesticide residue. Some of the value addition can be achieved by proper use of pesticides and by growing fruits and vegetables organically. Fruits and vegetables can be processed in a variety of ways to extend their shelf-life. New ways of presenting fruits such as the development of functional juices and beverages, nutritious and tasty fruit bars will be more attractive to the consumers.

The following key points emerged during discussion in this session:

- Consistency in quality, storage, safety and availability is crucial.
- Priority R&D areas: quality evaluation, certification, application of available technology, tracking and loss minimization, “On-time” delivery and risk minimization.
- Knowing the attributes valued by the final consumers of the product, understanding the critical control points of the supply chain and the effects of handling are prerequisites for value addition.
- Implementing quality systems plus continuous R&D from seed to shelf must be carried out.
- Asia-Pacific countries should collaborate in R&D efforts in order to avoid overlapping and reduce costs, optimize human resource utilization, and reduce the time for product development from laboratory to market.
- Value addition of horticultural produce begins from the farmer’s field and can be implemented at different stages of handling and processing.
- Appropriate investment is needed in priority research areas and in developing human resources.

Session 5: Group discussions for identifying future regional ARD strategy towards strengthening postharvest and value addition technologies.

Chairperson: Prof. Dr. Robert E. Paull, University of Hawaii, USA.

The participants were divided into four breakout groups to identify future regional ARD strategies towards strengthening postharvest and value addition of horticultural produce:

I. Postharvest of fruits and vegetables - Facilitator: Prof. Dr. Robert E. Paull

II. Postharvest and value addition of floriculture - Facilitator: Dr. Uulke Van Meeteran

III. Postharvest and value addition of herbs and medicinal crops - Facilitator: Prof. Ramlan Abd. Aziz

IV. Value addition of fruits and vegetables - Facilitator: Prof. Dr. Aminah Abdullah

Elaborate discussions took place in each group during which different issues were identified, and strategies and action plans to address these were proposed:

Group I - Postharvest of fruits and vegetables

Issue	Strategy	Action plan
1. Postharvest losses	• Policy support • Quantitative loss estimate • Strategies to ensure PH technology adoption • Sharing information • Integrated PHM centre	• Ensure project funding for postharvest loss reduction • Survey losses of fruits and vegetables • Work with extension officer to increase their understanding of PH. • Organize Train the Trainer programs involving processors, wholesalers and retailers • Interactive workshops for PH workers /researchers • Documentation of best practices and success stories • Establish IPHM Centre at nodal points
2. Quality and quality losses	• Standardization of harvest maturity for quality • Avoidance of mechanical injury • Farmer-friendly PH technology	• Promote use of tools and techniques to determine harvest maturity • Promote use of recyclable crates and liners to reduce damage • Promote low cost on-farm storage and processing technology

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Issue	Strategy	Action plan
3. Safety	• Pesticide • Microbial technology • Modern technology	• Expand use of rapid pesticide residue assays • Ensure availability of potable water containing appropriate dose of chlorine for final washing • Application of sophisticated instrumentation for determination of microbial infection/pesticide residue
4. Public awareness	• Involve public institutions • Outreach to school and consumer groups • Health and consumption of fruits and vegetables • PH integration and logistics	• Strengthen collaboration between researchers and extension workers • Develop urban horticulture programs in conjunction with schools • Involve handlers, wholesalers and retailers in creating awareness • Developing awareness among all stakeholders regarding PH integration
5. New indigenous crops	• Market potential • Develop PH protocol • Infrastructure for PH handling	• Prioritize market survey of potential indigenous fruits and vegetables • Identify knowledge gaps in PH handling of indigenous crops • Carry out PH research and identify infrastructure required for PH handling and processing.

Group II - Postharvest and value addition of ornamentals

Issue	Strategy	Action plan
1. Production focus has moved from the traditional producing countries to countries where the climates are better and production costs are lower	• Most Asia-Pacific countries should benefit from this trend; hence, there is need to increase production per unit area and improve quality of produce	• Improve and adopt cost effective technologies and intensify extension and education
2. Constraints of high capital investment, infrastructure facilities and technical expertise	• Facilitate research, education and extension • Promote cooperation between investors and farmers/growers	• Provide government support for infrastructure development • Government extension services to farmers to be strengthened • Facilitate interaction, collaboration and information sharing between farmers, technical support and investors

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Issue	Strategy	Action plan
3. Countries like China have increased their production very fast. Is the demand for chrysanthemum and orchid sustainable for the next 5 years when countries focus only on one market (e.g. focus of Malaysia on Japan)?	• Need to explore new markets and transport hubs. Dubai develops a new international hub for import and export of cut flowers • Explore Dubai International Hub for exporting cut flowers to new markets	• Have some trial shipments to Dubai for cut flowers, foliage and potted plants • For new markets, try flowers other than chrysanthemum, especially tropical plants like *Heliconia* and Bird of Paradise (*Strelitzia*)
4. Decrease in use of sea shipment for chrysanthemum due to economic reasons - customers often prefer air shipments	• Attempt sea shipment to new markets	• Consolidate information about the developments in sea shipment of flowers
5. Short storage life (2 weeks) and vase life (1 week) of orchids makes it difficult to export to Dubai International Hub	• Use optimal transport chains • Look for preferred flowers in Dubai	• Conduct a market study in Dubai about the preference of flower variety • Use air shipment to Dubai with proper temperature management and pre-conditioning of the flowers
6. Quality awareness in the chain is not always sufficient when exporting flowers	• There exist no objective parameter to measure quality; therefore, trust of buyers in the producer is of utmost importance	• Concessions to quality should never been made • Quality guarantee programs can be introduced to get the trust of buyers
7. Branding the flower	• Using branding (e.g. Malaysia introduced 'Malaysia Best' brand) to distinguish the best quality produce	• Develop branding of high quality flowers • Popularize the brands
8. Consumers increasingly ask for environmental friendly produced flowers	• Implement certification for environmental friendly production (e.g. MPS-GAP, or Fair Flowers Fair Plants)	• Start with certification for the flower farm which will ensure that consumers get better quality and better price • Follow the standard protocol recommended by government
9. Change in consumer preference for flower shape and color from time to time	• Breeders must continue to develop varieties that meets consumer preference	• Remain updated about consumer preference and continue breeding • Continue breeding programs with appropriate germplasm, and conventional and modern breeding tools

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Issue	Strategy	Action plan
10. Potted plant industry is small compared to cut flower because it is quite expensive	• Develop cost cutting and pot life extending technologies • Emphasize the advantages of potted plants – some like Sansevieria can absorb toxic gases, therefore is good for health • Introduce potted orchid plants	• Research on handling of orchids and other ornamental potted plants to be expanded • Awareness generation about potted plants
11. Bent neck problem in roses is a major problem for exporting roses	• Select and develop cultivars that are most resistance to bacteria • Emphasize suitable additives to vase water	• Increase awareness about postharvest handling of cut flowers through practical publications • Continue breeding to improve vase life

Group III - Postharvest and value addition of medicinal and aromatic plants

Issue	Strategy	Action plan
Upstream (Production, postharvest and primary processing)		
1. Inadequate characterization of potential plants	• Screening of potential plants carrying specific bioactive compounds (bio-prospecting) • Ethno-botanical study	• Collection and screening using cutting edge technologies • Documentation of traditional knowledge with the help of local community and institutions
2. Overexploitation of wild resources	• Domestication of potential MAP species from the wild • Varietals improvement • Development of production technology	• Germplasm collection, Breeding and evaluation to be strengthened • Involvement of appropriate research institutions and farmers organization • Integrated farming with perennial crops in agro-forestry system of M&AP
3. Lack of planting material availability	• Rapid multiplication of planting material • Development of appropriate and efficient propagation technologies	• Development of conventional and biotechnological methods of rapid multiplication • Transfer of technology to industry and farmers • Organization of training workshop
4. Lack of quality control mechanism	• Adopt quality certification (GAP, GCP, GHP)	• Institute quality control system in the production chain to meet the required standards

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Issue	Strategy	Action plan
5. Lack of appropriate technologies in primary processing	• Participatory technology development in primary processing with the entrepreneurs/farmers and scientists	• Coordination for technology development to be initiated by appropriate research institutes and relevant ministries.
Downstream (Processing to final product development		
6. Lack of coordination within the supply chain	• Effective coordination, also ensuring economic equity among the stakeholders	• Coordination (government and non- government) must ensure semi-processing at farm level and final product formulation at mother unit so as to benefit all stakeholders
7. Lack of appropriate technologies	• Ensuring R&D institutions produce appropriate technologies to meet the needs of smallholder farmers and industry	• Coordination for technology development by appropriate research institutes and relevant ministries
8. Lack of quality control mechanism	• Adopt certification (GMP and HACCP)	• Institute quality control system in Semi-finished and finished products
9. Lack of human resource development	• Organize effective training programs for farmers/ entrepreneurs	• Research institutes to organize training programs to ensure technology delivery

Group IV - Value addition of fruits and vegetables

Issue	Strategy	Action plan
1. Demand for health and wellness but lack of R&D to substantiate health claim	• Intensive R&D work • Collaboration within the country (public institutions, university, industries) and the region	• Identify and prioritize focus research area • Indentify areas of common interest within the Asia-Pacific region and initiate collaborations
2. Lack of financial resources for human resource development and technology development	• Sourcing funding nationally, regionally and internationally	• Collaborate and identify niche areas and funding agencies • Formulate programs and technical working groups • Through APAARI to solicit funding from various sources
3. Cost intensive processing technology	• R&D to develop cost effective technology • Use of green technology (solar energy)	• National and regional public and private sector institutions collaboration in R&D • Sharing information /experience within the region

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Issue	Strategy	Action plan
4. Food safety (biological, chemical and physical) and quality concern	• Implementation of GMP/ GHP, monitoring QMS	• Governments to facilitate food safety and quality guidelines implementation • Conduct systematic training programs
5. Dearth of information and knowledge on value additions	• Information gathering and sharing among APAARI member countries • Conduct training programs on information management	• Development of database regarding tropical fruits and vegetables and their nutritional value (bioactive phytochemical) • Organize relevant training program • Establish a working group • Establish the network/contact point for technical subjects within APAARI
6. Packaging: Lack of innovative packaging and improper use of packaging material	• Improve packaging design and material • Strengthen R&D on packaging	• Establish packaging facilities (Thailand is an example) • Contract packaging (e.g. Tetrapack) • Conduct R&D on smart (sensor and biosensor, active packaging) and green packaging technology (agro- waste and recycle)
7. Marketing: Lack of market information for producer and need for readable and understandable labeling	• Information gathering • Provide detailed information on product	• Conduct market access studies • Provide information through intelligent packaging (bar code)
8. Abundance of agro-waste	• Utilization of waste – reuse, reduce and recycle	• R&D on utilization of agro-waste • Value-add to agro-waste (e.g. product/ ingredient)
9. Mechanization: Unavailability of suitable machine for fruit and vegetable PHT processing	• R&D for appropriate machinery	• Develop suitable machinery for targeted fruit and vegetables Interact with farmers and industry
10. Short shelf life of selected fruits and vegetables (e.g. rambutan, longan, dokong, jamun, litchi)	• R&D to prolong shelf life	• Conduct more research on related issues and crops • Develop new products and processes (e.g. minimally processed fruits/ vegetables) • Establish collection centres
11. Availability of raw material, price fluctuation	• R&D to improve supply chain system	• Develop/implement optimum storage temperature for selected fruits and vegetables

Plenary Session: Discussion on group recommendations and general recommendations

Chairperson: YM. Tengku Ab. Malik Tengku Maamun, Director, Horticulture Research Center, MARDI, Malaysia.

The facilitators of each group presented the outputs of group discussions. The following Group and General Recommendations were made after further discussion:

Recommendations of Breakout Group I (Postharvest of fruits and vegetables)

- Promote farmer-friendly postharvest technology by developing simple postharvest handling systems for small farmers.
- Efforts should be made to reduce quality losses by adopting maturity standard and using recyclable plastic crates to prevent mechanical damage.
- Safety standards to be maintained by using chlorine in washing water, eliminating pesticide residue and monitoring their presence with sophisticated instruments.
- Assess the potential of indigenous fruits and vegetables, identify knowledge gaps in their postharvest handling and develop postharvest protocols.
- Advocate awareness programs about health benefits of fruits and vegetables involving public institutions, schools and consumers.
- Survey to be conducted to estimate quantitative losses of fruits and vegetables of the region.
- Appropriate strategies should be worked out to ensure that extension officers increase their understanding on postharvest aspects.
- Strengthen information sharing throughout the region.
- Establish Integrated Post Harvest Management Centers (IPHMC) to train the trainers and act as service hubs.

Recommendations of Break out Group II (Postharvest and value addition of ornamentals)

- New markets for cut flowers need to be explored and accessed, particularly where international hubs have been developed, and trial shipments should be made. Tropical flowers such as Bird of Paradise, *Heliconia* etc. must be promoted.
- Awareness about the new developments in sea shipment technology should be propagated.
- Market study should be undertaken to learn about customer preference of orchid varieties. It is necessary to use transport chains with proper temperature management and pre-conditioning of flowers.
- Quality awareness and guarantee programs must be introduced. Branding can be promoted as guarantee of quality.

- Certification of environment friendly farms should be implemented to satisfy the requirements of consumers.
- Breeding program should be continuous to meet changing customer tastes.
- Some indoor potted plants such as *Sansevieria* can absorb toxic gases; therefore, their health advantages should be emphasized. Research on potted orchids and ornamental plants has to be enhanced.
- Increase awareness about postharvest handling of cut flowers. This can be done through scientific publications and popular articles.
- Improve and intensify education and extension services in order to facilitate interaction and sharing of information between farmers and technical support personnel.

Recommendations of Break out Group III (Postharvest and value addition of herbs and medicinal crops)

- Use of modern technologies to screen potential plants that carry specific bio-active compounds must be undertaken.
- It is important to document traditional knowledge with the help of local communities/ institutions.
- Research institutions and farmer organizations to be involved in the domestication of potential MAP species from the wild, developing production technologies and varietal improvement. Farming of MAPs to be integrated with other perennial crops.
- Development of appropriate and efficient propagation technologies to overcome the problem of lack of planting material. Farmers must be involved in the multiplication of planting material.
- There is very little quality control in raw material production. Quality certification (GAP, GHP) must be adopted and quality certification (GMP and HACCP) instituted for semifinished and finished products.
- Development and coordination of technologies in primary processing should be the responsibility of appropriate research institutes and relevant ministries and should also involve entrepreneurs and farmers.
- Coordination (government and nongovernment) must ensure semiprocessing at farm level and final product formulation at mother unit for the benefit of all stakeholders.
- Coordination for technology development should be the responsibility of research institutes and relevant ministries so that appropriate technologies are available to industries involved in final product development.
- Research institutes should organize training programs for farmers and entrepreneurs to ensure technology delivery.

Recommendations of Break out Group IV (Value addition of fruits and vegetables)

- Identify and prioritize focus research areas of common interest within the Asia-Pacific region to substantiate claims of benefits to health.

- Collaborate and identify niche areas of value addition, formulate programs and set up technical working groups.
- Solicit funding for human resource and technological development from various sources and with the support of APAARI
- Collaborate in R&D and information sharing within the region for cost effective and green technologies.
- Formulate and implement systematic training programs to maintain food safety and quality control.
- Development of tropical fruits and vegetables database with information on their nutritional value (bioactive, phytochemical).
- E-working/learning groups should be established involving APAARI as contact point for technical subjects.
- R&D on packaging needs to be strengthened in order to improve material and design. Promotion of centralized packaging facilities and contract packaging.
- Market access studies to be conducted.
- Utilization of waste in the form of product or ingredient. It is essential to re-use, reduce or re-cycle waste.
- Low cost equipment/machinery to be developed especially for small farmers.
- To prolong shelf life, storage at optimum temperature to be implemented. R&D on new products and processes (e.g. minimally processed fruits/vegetables).
- Collection centers to be established to improve supply chain system.

General Recommendations

The expert consultation recognized that horticultural produce comprising fruits, vegetables, ornamentals and medicinal herbs constitutes an important component of agriculture sector in the Asia-Pacific region. It contributes significantly to farmers' income, and food and nutritional security. Horticultural produce provides employment and livelihood security to large numbers of people involved in production, processing and marketing chain. Being an important export item of several Asian countries, horticultural produce also contributes to foreign exchange earnings. However, substantial postharvest losses occur, though the figures vary over countries. These losses take place at all stages of marketing chain and result in losses to farmers, deterioration in quality, reduced nutritional value and high costs to consumers. Hence, there is an urgent need to reduce postharvest losses by adopting appropriate policies, technologies and regional cooperation. Recommendations on the following broad areas were adopted after discussion:

I. Policy support – there is a need to enhance policy support including funding for R&D and trainers' training in postharvest technology.

II. Detailed assessment of the postharvest losses to be made along the entire production and marketing chain to identify the critical gaps and remedial measures.

III. Development of infrastructural support base for postharvest management that will facilitate safety, quality retention, on-time delivery, and reduce handling costs and losses.

IV. Appropriate and integrated postharvest management practices are essential. Low cost storage, handling and processing technologies that can be adopted by small farmers are most suited for countries of this region.

V. Establishment of a regional Integrated Post Harvest Management Center (IPHMC) that will couple an education center with a one-step shop selling postharvest technologies and services.

VI. Train rural, urban and peri-urban horticultural growers in pre- and postharvest handling, processing and marketing techniques.

VII. Emphasis to be given on indigenous fruit and vegetables and waste utilization.

VIII. Postharvest information management is an emerging need for farmers to keep abreast of the market demands, and labeling and traceability requirements. Infrastructure and local skills need to be developed for the benefit of resource poor farmers to remain competitive in the globalized markets.

Closing Session

In his closing remarks, YM. Tengku Ab. Malik Tengku Maamun pointed out that the Meeting had provided a valuable update on the postharvest and value addition information, by highlighting the status of ARD on postharvest and value addition, recent technologies for managing quality and safety, experiences of farmers and farmer organizations on the technology, as well as overview global ARD future directions on postharvest and value addition of horticultural produce. Several issues, strategies and future action plans have been identified for implementation in the Asia-Pacific region. Besides, the Meeting was able to strengthen linkages among member countries in the Asia-Pacific region, so as to continuously share the information, knowledge and findings on postharvest and value addition technologies. He thanked the APAARI for organizing the Meeting in Malaysia and hoped that the collaboration among APAARI member countries will promote intensive and appropriate agriculture research development for brighter future of horticultural industry.

Technical Tour

1. Malaysian Agricultural Research and Development Institute (MARDI): MARDI has the mandate to conduct research in agriculture, food and agro-based industries. Cutting edge technologies in food processing and postharvest handling are also developed for horticultural and livestock products. New techniques are being developed in environmental management and optimum utilization of agricultural resources, particularly soil, water and genetic resources. Besides performing R&D, MARDI also provides technical services and entrepreneurship development advisory, consultancy and technical trainings and contributes significantly to the global knowledge corpus. MARDI provides a pool of experts in relevant fields and development and processing and also technology up scaling.

The participants were welcomed by Datuk Dr. Abd Shukor, Director General, MARDI who appraised them of the organizational set up and functioning of MARDI. On behalf of the participants, Dr. Karihaloo offered thanks to the DG and the scientists of MARDI.

2. Malaysian AgriFood Corporation (MAFC) Berhad: The participants were briefed with the help of power point presentation about the working of the MAFC and thereafter had an opportunity to visit the different facilities available at MAFC. MAFC is an integrated food supply chain management company. Accredited to ensure sustainable agriculture practices at every level of the food supply chain, the company seeks to create value by partnering with government agencies and industry players to supply safe and top quality fresh produce for healthier living.

MAFC is steered by a team of industry experts and professionals drawn from extensive and diverse specialty backgrounds. Each is entrusted with specific portfolio responsibilities to seek and ensure the use of cutting-edge technologies to optimize MAFC's operative efficiency across the entire food supply chain. MAFC is further complemented by the subsidiary company, Cold Chain Network Sdn Bhd (CCN) – an integrated food distributor with total refrigeration logistics and warehousing services. CCN caters to the diverse requirements of customers, which range from large hypermarkets to independent food service operators.

In addition to sourcing the highest quality fresh produce MAFC also integrates value-added farm gate to retail gate services to ensure reliable and timely delivery of safe and quality products to the customers.

3. Taman Warisan Pertanian is an agricultural heritage park where Malaysians observe the process of cultivating palm cocoa, rubber and a variety of fruits, herbs and spices, and visit areas where the manufacture of agricultural products take place. One example is the Rubber Processing Demonstration Area. The park emphasizes the role and importance of Malaysia's commercial agriculture. This includes rubber tree, oil palm, coffee, tea, cocoa, fruits, herbs and spices.

The participants had the privilege to take a guided tour of the heritage park in battery operated carts.

4. The Malaysia Agriculture Horticulture and Agrotourism (MAHA): The MAHA is Malaysia's leading agricultural show hosted by Ministry of Agriculture and Agrobased Industries and organized by the Federation Agriculture Marketing Authority. It is also a platform for postharvest and best agro-food processing companies. The show was held from November 26 2010 to December 5 2010.

5. The Malaysian Agro Exposition Park Serdang (MAEPS) is Asia's largest and most comprehensive showground with exposition facility. Owned by the Ministry of Agriculture and Agro-based Industry, Malaysia, MAEPS was conceived on the same platform which the Ministry has used to successfully rebrand the agriculture sector as evidenced by its motto "Agriculture is business". The main objectives of MAEPS are:

- To act as an information centre, for creating awareness on the latest innovation and new technologies to the target groups, with the aim of increasing their agriculture production, standard of living and income.
- To provide a platform of meetings for the sellers and the buyers.
- To promote agriculture as a career, that could provide promising future and guaranteed lucrative income in order to attract entrepreneurs and the young generation.
- To position Malaysia as a centre of excellence in the development of agriculture and the agro-based industry in order to attract private and foreign investment.

More than 2,000 Exhibitors from 28 countries took part in The Malaysian Agriculture, Horticulture and Agrotourism Exhibition 2010, or MAHA 2010, showcasing the latest technologies and innovations in the agriculture, agro-based, horticulture and agrotourism industry, and displaying not less than 25,000 products.

Expert Consultation Meeting on Postharvest and Value Addition of Horticultural Produce 2010

Date: 29 November - 2 December 2010

Program

29 November 2010	
0730	Registration
0830	Remarks by the Chairman of the Organizing Committee
Session 1 **Status of agricultural research development (ARD) initiatives on postharvest and value addition of horticultural produce in the Asia-Pacific region** *Chairperson* **Dr. J.L. Karihaloo, Coordinator, APCoAB, APAARI**	
0840	Status of ARD initiatives on postharvest and value addition of horticultural produce in South Asian Region Speaker: *Prof. Dr. Nadeem Akhtar, Abbasi PMAS-Arid Agriculture University Rawalpindi, Pakistan*
0900	Status of ARD initiatives on postharvest and value addition of horticultural produce in Southeast Asia Speaker: *Dr. Saipin Maneepun, Kasetsart University, Thailand*
0920	Studies and extension on precooling technology of horticultural crops in Taiwan Speaker: *Dr. Lin Doung-Liang, Tainan District Agricultural Research and Extention Station, Chinese Taipei*
0940	Status of ARD initiatives on postharvest and value addition of horticultural produce in the Pacific Region Speaker: *Dr. Raghunath D. Ghodake, National Agricultural Research Institute, Papua New Guinea*
1000	Special report: Recent ARD achievements on postharvest and value addition of horticultural produce in Malaysia Speaker: *Abdullah Hassan, Malaysian Agricultural Research and Development Institute, Malaysia*
1020	Tea Break

Session 2

Technology spectrum for managing quality and safety of horticultural produce

Chairperson

Dato' Dr. Sharif Haron, Deputy Director General (Research), MARDI

1040	Horticulture CRSP, a long term commitment by USAID to address poverty and hunger of the rural poor in developing countries Speaker: *Prof. Dr. Robert E. Paull, University of Hawaii, USA*
1105	Capacity building in support of horticultural chain management in Asia and the Pacific: FAO's initiatives and activities Speaker: *Dr. Rosa Rolle, FAO, Bangkok, Thailand*
1130	Low cost postharvest technology and value addition of fruits and vegetables for the benefit of small farmers of South Asia Speaker: *Prof. Susanta K. Roy, Amity International Centre for Postharvest Technology and Cold Chain Management, Amity University, India*
1155	Simple, reliable and cost effective postharvest machineries for horticultural produce Speaker: *Dr. R.T. Patil, Central Institute of Post Harvest Engineering and Technology, India*
1220	Disinfectant electrolyzed acidic water and other antimicrobial agents as food additives for fresh and fresh-cut produce Speaker: *Prof Dr. Hidemi Izumi, Kinki University, Japan*
	Information management as an emerging postharvest technology issue for resource poor farmers (paper by *Dr. Ajit Maru and Dr. Divine Njie, Food and Agriculture Organization (FAO), Rome, Italy* circulated, not presented)
1245	Lunch
1400	**Opening ceremony** • Welcoming Address by Dr. J.L. Karihaloo, APAARI Secretariat • Welcoming Address by Datuk Dr. Abd. Shukor Abd. Rahman, Director General MARDI and Chairman of APAARI • Opening Address by Y.B. Dato, Wira Mohd. Johari Baharom, The Honourable Deputy Minister of Agriculture and Agro-based Industry, Malaysia • Group Photograph
1530	Tea Break

	Session 3 **Initiatives and experiences of farmers and farmer organisations on postharvest handling technology of horticultural produce** *Chairperson* **Dr. Susanta K. Roy, Professor Emeritus, Amity University, Uttar Pradesh, India**
1600	Postharvest and value addition of horticultural produce in Bangladesh: the experiences of farmers and farmers organizations on postharvest technologies Speaker: *Dr. Md. Saleh Ahmed, Hortex Foundation, Bangladesh*
1620	Storage and post harvesting technologies: a Himalayan initiative Speaker: *Dr. Anil P Joshi, Himalayan Environmental Studies & Conservation Organization, India*
1640	Processing of essential oils from herbs – from R&D to pre-commercialisation Speaker: *Ahmad Ab. Wahab, Malaysian Agricultural Research and Development Institute, Malaysia*
2000	Reception Dinner
	30 November 2010
	Session 3 (continue) *Chairperson* **Dr. Susanta K. Roy, Professor Emeritus, Amity University Uttar Pradesh, India**
0830	Initiatives and experiences of farmers and farmer organisations on PHT of horticultural produce in the Philippines Speaker: *Amihan Jonos, Federation of Free Farmers, Philippines*
0850	Initiatives and experiences of exporters association on PHT of horticultural produce in Malaysia Speaker: *Ricky Y.K. Yong, Malaysia Fruit Exporters Association, Malaysia*
	Session 4 **Global ARD future directions on postharvest and value addition of horticultural produce** *Chairperson* **Abdullah Hassan, Dputy Director, Horticulture Research Centre, MARDI, Malaysia**
0910	Overview of future directions for ARD for postharvest and value addition of horticultural produce - fruits and vegetables. Speaker: *Prof. Dr. Robert E. Paull, University of Hawaii, USA*

0930	Global ARD future direction on postharvest and value addition of floriculture - quality increase after harvest of cut flowers Speaker: *Dr. Uulke Van Meeteran, Wageningen University, The Netherlands*
0950	Global ARD future direction on postharvest and value addition of herbs and medicinal crops Speaker: *Prof. Ramlan Abd. Aziz, Universiti Teknologi Malaysia (UTM), Malaysia*
1010	Global ARD future direction on value addition of fruits and vegetables Speaker: *Prof. Dr. Aminah Abdullah, Universiti Kebangsaan Malaysia (UKM), Malaysia*
1030	Tea Break

Session 5

Group discussions for identifying future regional ARD strategy towards strengthening postharvest and value addition technologies

Chairperson/Head Facilitator

Prof. Dr. Robert E. Paull, University of Hawaii (USA)

1100	• Briefing by Head Facilitator • Break out groups: I. Postharvest fruits and vegetables. Facilitator: Prof. Dr. Robert E. Paull (USA) II. Postharvest and value addition of floriculture. Facilitator: Dr. Uulke Van Meeteran (The Netherlands) III. Postharvest and value addition of herbs and medicinal crops Facilitator: Prof. Ramlan Abd. Aziz (Malaysia) IV. Value addition of fruit and vegetables Facilitator: Prof. Dr. Aminah Abdullah (Malaysia)
1300	Lunch
1400	Continued group discussion session

Plenary Session

Discussion on group recommendations and general recommendations

Chairperson

YM. Tengku Ab. Malik Tengku Maamun, Director, Horticulture Research Center, MARDI, Malaysia

1600	• Presentation of outputs from Group Discussions, and • Summary of workshop by Head Facilitator
1645	Closing ceremony
1700	Tea

	01 December 2010 **Technical Tour**
0830	MARDI, Serdang
1000	Malaysian Agrifood Corporation (MAFC), Puchong
1300	Taman Warisan Pertanian (The Agriculture Heritage Park), Putrajaya - lunch and guided tour
	02 December 2010 **Technical Tour**
1000	Visit to the Malaysian Agriculture, Horticulture and Agro-Tourism (MAHA) International 2010 Show, Malaysia Agro Exposition Park Serdang (MAEPS)

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Asia-Pacific Association of Agricultural Research Institutions

Asia-Pacific Association of Agricultural Research Institutions (APAARI) was established in 1990 at the initiative of Food and Agriculture Organization of the United Nations and most of the National Agricultural Research Systems (NARS) of the Asia-Pacific region. Its mission is to promote the development of National Agricultural Research Systems in Asia-Pacific region through facilitation of inter-regional, inter-institutional and international partnerships.

APAARI's vision is that Agricultural Research for Development (ARD) in the Asia-Pacific region is effectively promoted and facilitated through novel partnerships among NARS and other related organizations so that it contributes to sustainable improvements in the productivity of agricultural systems and to the quality of the natural resource base that underpins agriculture, thereby enhancing food and nutrition security, economic and social well being of communities and the integrity of the environment and services it provides.

The overall objectives of APAARI are to foster the development of agricultural research in the Asia-Pacific region so as to:

- Promote the exchange of scientific and technical information
- Encourage collaborative research
- Promote human resource development and capacity building
- Build up organizational and management capabilities of member institutions
- Strengthen cross-linkages and networking among diverse stakeholders

To know more about APAARI, please visit: www.apaari.org

Asia-Pacific Consortium on Agricultural Biotechnology

Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB) was established in 2003 under the umbrella of Asia-Pacific Association of Agricultural Research Institutions (APAARI). APCoAB has the mission to "harness the benefits of agricultural biotechnology for human and animal welfare through the application of latest scientific technologies while safeguarding the environment for the advancement of society in the Asia-Pacific Region". APCoAB's main thrusts are (i) to serve as a neutral forum for the key partners engaged in research, development, commercialization and education/learning of agricultural biotechnology as well as environmental safety in the Asia-Pacific region; (ii) to facilitate and promote the process of greater public awareness and understanding relating to important issues of IPR, sui generis systems, biosafety, risk assessment, harmonization of regulatory procedures, and benefit sharing in order to address various concerns relating to adoption of agricultural biotechnology; and (iii) to facilitate human resource development for meaningful application of agricultural biotechnology to enhance sustainable agricultural productivity, as well as product quality, for the welfare of both farmers and consumers.

To know more about APCoAB, please visit: www.apcoab.org

About Malaysian Agricultural Research and Development Institute (MARDI)

VISION

To be a world-renowned R&D organization in food, agriculture and bio-based industries by 2015

MISSION

To create, innovate, transfer and apply knowledge, competencies and services to transform the national food, agriculture and bio-based industries towards increased commercialization and competitiveness

GOALS

To create new knowledge and commercialisable technologies and services for customers
To develop and sustain a motivated, competent and productive knowledge-based workforce
To achieve excellent in operating mechanisms
To enhance and sustain innovativeness
To increase customer value
To improve financial strength
To develop state of the art physical and technical infrastructure
To achieve excellence through better marketing capabilities
To enhance collaborative effort with international organizations

R&D ACTIVITIES ARE TARGETED TOWARDS:

Adopt customer oriented corporate culture for quality performance and excellence
Greater emphasis on human resource development and utilization
Embrace a knowledge-based culture through continuous learning
Enhance caring and sharing values, and team work
Develop management transparency and empowerment with accountability and responsibility
Higher sense of belonging and pride in the organization
Key performance indicators (KPI) based performance measures
Greater global presence

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