

FRUITS FOR THE FUTURE IN ASIA

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FRP
FORESTRY RESEARCH PROGRAMME

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FRUITS FOR THE FUTURE IN ASIA

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PREFACE

Asian farmers cultivate a variety of fruit trees on homestead farms producing multiple products including medicine, aromatics, herbs and spices. Produce from fruit trees can generate more income than from field crops. Different fruit trees have different characteristics and uses, even in the same country. Therefore, the processing and marketing structures and consumer requirements are different, and for many small-scale producers, they remain unknown. Small-farmers especially, encounter difficulties in marketing fresh quality produce and experience loss of quality during storage and transport.

Realising the importance of fruit trees in the improvement of livelihood of poor people in the region, ICUC, with the Horticulture Research Institute of Thailand and with DFID-FRP funding organized a regional consultation meeting in Bangkok in February 2002.

This book is the result of this meeting, where scientists, NGOs and small scale entrepreneurs discussed the present status on the postharvest handling, processing and marketing of UTFT (Underutilised Tropical Fruit Trees) and their products in Asia. Presentations from experts in each country on the tropical fruits highlighted the need for research on this valuable natural resource which not only improves the livelihoods of poor people but will maintain biodiversity and environmental sustainability. The presentations included the need for the development of a research programme on underutilized fruit trees on the post-production science and product and market development and we were delighted that the working groups of the two subregions managed to come out with detailed recommendations of research on processing and how products can be linked with market chains. The individual papers included in these proceedings have not been altered except where required for formatting.

We would like to thank DFID-FRP for funding this project and for the organization of the meeting in Bangkok, which has given us an insight into each country's present position and development and utilisation of underutilized crops in the whole region of Asia.

The meeting and proceedings of the meeting were not possible without the help of the Honourable Minister of Agriculture and Cooperatives of Thailand, Mr. Somsak Singholka, DG and his staff, particularly Mr. Prasat Anuput, Director, Horticultural Research Institute, Thailand, which is a partner institution of ICUC.

Lastly, we were fortunate to have the Honourable Ambassador of the UK to Thailand, Mr. Lloyd Barnaby Smith, as the Chief Guest and gave an excellent speech on the importance of these fruit trees in Asia.

PREAMBLE

The Fruits for the Future Programme was established in 1995 with an overall goal to increase income generation, alleviate poverty and improve the livelihood of poor farmers through the promotion of underutilized tropical fruit trees (UTFTs). In trying to achieve this goal, ICUC has implemented a regional project on the propagation and technology transfer of 3 species of UTFTs through the UTFANET (Underutilised Tropical Fruit Trees in Asia Network) and a global project, 'Fruits for the Future', on the collation and dissemination of information on the production, harvesting, processing, utilization and marketing of UTFTs.

The purpose of this meeting was threefold:

- to launch the 'Fruits for the Future' project publications
- to assess the usefulness, uptake and impact of these publications from the point of view of the various beneficiaries present in the meeting
- to discuss the status of UTFTs in the region and to produce recommendations from the stakeholders on the requirements for further activities.

A record of the presentations relating to information uptake and impact and the country status reports from the Asian region are provided in these proceedings.

It was apparent from the presentations of status reports by 9 countries and discussions of two working groups (South Asia and South East Asia), that technologies for post-harvest handling and processing of UTFTs for local and national markets are available at research laboratories. However these technologies are not appropriate for household processing and need to be adapted for village level processing. Furthermore information is scattered and not easily accessible by householders, small traders and entrepreneurs. In addition, the available technologies need to be evaluated and adapted for local, regional and international markets. Little information currently exists in the region about products or marketing at local, regional and international levels.

It was also determined by the working groups that the needs of South Asia (Bangladesh, India, Nepal, Pakistan and Sri Lanka) and South East Asia (Indonesia, Philippines, Thailand and Vietnam) are different as most of the countries are focused on a single crop for processing and marketing and that the crop differs from country to country.

The recommendations from the consultation meeting and workshop were the proposed formulation of projects as follows:

- a pilot project to assemble information on post-harvest handling, processing and market chains, and to develop mechanism(s) for dissemination of this information to householders, small traders, entrepreneurs and others in the region
- research projects on post-harvest handling, processing and marketing of UTFTs.



OPENING ADDRESS

Mr. S Singholka
Director General, Department of Agriculture

Mr. Lloyd Barnaby Smith, British Ambassador for Her Majesty's Government in Bangkok; Dr. R.B.Singh, Assistant Director-General of FAO; Dr. Roger Smith, Chairman of ICUC; Dr. John Palmer, DFID-FRP Manager; Distinguished Participants, Ladies and Gentlemen:

First of all, I would like to convey the sincere apology of His Excellency, Mr. Shucheeep Hansavard, Minister of Agriculture and Cooperatives, for not being able to attend this meeting due to other official commitments. It is therefore my pleasure to address this Opening Ceremony on his behalf. I am delighted to meet a group of prominent scientists who recognise the importance of underutilised fruits.

Asia is the centre of diversity for a large number of tropical fruits, particularly the South and Southeast Asia Region where there is a great potential for underutilised fruits in increasing farmer's income.

I would like to acknowledge the effort of the International Underutilised Crops (ICUC) in exploring the potential of underutilised fruits for food, nutrition, and increasing rural income. Nevertheless, the Underutilised Tropical Fruits in Asia Network (UTFANET) deserves commendation for the activities already implemented under a strong collaborative partnership among countries in the region. This enables the conservation, efficient use of genetic resources, and exchange of expertise and technology.

This meeting of experts in this field is therefore justified whereby we could review the constraints and draw up plans on how we could more efficiently and effectively attain the objectives outlined on this network. The key words that we must address among others are: comprehensive compilations of information, income generation, nutrition, food security, diversification, and use in agroforestry systems.

I look forward that this meeting shall bring a stronger relationship among partners, and an active participation during the exchange of knowledge and information. Let us join I hands in getting the best out of this noble effort.

Finally, on behalf of the Ministry of Agriculture and Cooperatives, and on my personal behalf, welcome to all of you, and thank you for convening this meeting here in Thailand. As a host, we shall do our best to attend to your needs for the next three days.

I now declare the Meeting on Fruits for the Future open. Thank you.

WELCOME ADDRESS

Mr. Roger Smith, Chairman, ICUC Board of Trustees

Mr Manoch Thongjein, representing the Director General, Department of Agriculture, Thailand; Mr Somsak Singholka, representing the Honourable Minister of Agriculture and Co-operatives of Thailand; Mr Lloyd Barnaby Smith, H. M. Ambassador of the UK to the Government of Thailand; Honourable delegates, colleagues and friends.

It is indeed an honour and a privilege to welcome you all, on behalf of the International Centre for Underutilised Crops, to this important meeting. We are gathered here for the next few days to officially launch the first three of 10 books on underutilised tropical fruits which ICUC is publishing as the outputs of a project funded by the UK Department for International Development's (DFID) Forestry Research Programme (FRP). Secondly we are holding a Regional Workshop on the Processing and Marketing on Underutilised Tropical Fruits, a key meeting for the Global Programme "Fruits for the Future".

We are privileged to have with us the principle authors of the three books being launched: Prof. Gunasena, the author of the book on Tamarind, Dr. Pareek, the author of the book of Ber and Dr. Pinto, the author of the book on Annona species. I welcome all three, and shortly they will present their books to our Guest of Honour, our Chief Guest and our Special Guest.

The workshop on Processing and Marketing will enable participants, including those from the Underutilised Tropical Fruits in Asia Network (UTFANET), to identify opportunities and constraints connected with the increased marketing of fruits and processed products from the many underutilised fruits in the warmer parts of the world. It is hoped that the workshop will produce a timetable and action plan to deal with the main constraints and to realise the identified opportunities, for the benefit of farmers, processors, traders and consumers of our fruits.

I would like to take this opportunity to say a few words about the structure and future aspirations of ICUC. ICUC is managed by an International Board of Trustees, which meets annually in the UK. The Board has nominated a Management and Programme Committee, which looks after the affairs of ICUC between Board Meetings. Staff of ICUC are based in the headquarters at the University of Southampton, UK and at one or other of its regional offices. Our Director, as we all know, is Nazmul Haq. ICUC is about to appoint a programme co-ordinator to work with the Director. ICUC employs secretarial support in Southampton, and has other staff employed on the strength of its various projects. These include Angela Hughes, who manages

the Fruits for the Future project; Oliver Bromley, our Information Technologist; Marilyn Rondolo, who manages UTFANET, and James Alleman who manages our programme on Indigenous Vegetables in Eastern and Southern Africa, within our African Programme: Southern and Eastern African Network on Underutilised Crops (SEANUC). Here in Asia, a new programme on vegetables: The Underutilised Tropical Vegetable in Asia and the Pacific Network (UTVAPNET) has recently been launched. ICUC also hopes to establish a network in Latin America and the Caribbean region in the future.

ICUC's activities are organised by commodity groups - including the Fruits and Nuts Programme, the Indigenous Vegetables Programme and the Industrial Crops Programme.

The collection, generation, transfer and dissemination of knowledge is a primary function of ICUC. This is achieved through the conduct of research, the generation of data-bases and the production of the Global Newsletter on Underutilised crops. Information is also available and distributed by the ICUC web-site.

ICUC is building up a consortium of stakeholders from all sectors - similar to those who participate in the Global Forum on Agricultural Research for Development (GFAR). Stakeholders include advanced research institutions, universities, the private sector, NGOs and farmers' groups. GFAR has recently established a programme on Underutilised and Orphan Commodities (UOC), facilitated from an office in the International Plant Genetics Resources Institute (IPGRI) based in Rome - and ICUC works closely with the facility.

With these few words, I again welcome all our honoured guests and participants, and anticipate fruitful (sic) discussions which will lead to new initiatives benefiting all our stakeholders, particularly the poorer producers. ICUC is committed to the reduction of poverty and the improvement of human welfare and livelihoods.

MESSAGE FROM JOHN PALMER, DFID-FRP

Dr. John Palmer
Manager of DFID's Forestry Research Programme (FRP)

Mr. Chairman, Your Excellencies, Ladies and Gentlemen,

The Forestry Research Programme (FRP) of the United Kingdom Department for International Development has supported research on indigenous tropical and sub-tropical fruit trees for several years. Early work was as a minor component of research on dry zone hardwoods intended primarily for local rural communities which were lacking fuelwood and dry season fodder. Work has concentrated on fruit trees which are locally important for domestic use and in-country commercial markets but which generally do not enter international trade. More recently, and in collaboration with the CGIAR International Centre for Research in Agroforestry (ICRAF), FRP has supported research projects which:

- synthesise scattered knowledge about major species of indigenous tropical and sub-tropical fruits into monographs which are then widely distributed,
- determine how important such fruit trees are in household and community livelihoods, and what are the constraints on increasing incomes or diminishing vulnerability through enhanced production, processing or marketing of fruits,
- examine how fruit tree production or processing fits with other elements of rural livelihoods, especially those elements which involve other natural resources.

FRP has tended to focus on the more socio-economic factors, while ICRAF has increasingly taken on the coordination of the biological studies and training for tree improvement through genetic selection and vegetative propagation.

Although the productivity of some species can be improved quite rapidly through selection and grafting, within three years for African plum (*Dacryodes edulis*), the time frame for significant improvement through horticulture is exceeding the time horizon for FRP projects. So FRP will focus support on the next phase on processing, marketing and market intelligence. A planning meeting will be held in London at the end of February 2002 to make progress on strategy for this phase.

FRP anticipates attention to processing which will extend the shelf life of the fruits of these trees. Some popular species have irregular fruiting, or fruiting in glut proportions which overwhelm traditional markets. So spoilage and

loss is enormous, and incentives for more intensive tree management are small. FRP will need to establish contact with food research institutes and faculties which may have large amounts of academically-derived knowledge, and will help to reorganise the knowledge for practical application at household and small-scale community levels. It is anticipated that FRP will support practical training courses in bottling, canning and solar drying.

FRP will also put community representatives in touch with market intelligence systems, such as specialists in farm-orientated radio.

This next phase of research support builds on projects such as the one on fruit tree monographs which we are celebrating today. FRP is pleased to have been able to support this project, coordinated from the International Centre for Underutilised Crops at the University of Southampton, UK. The wide range of contacts which ICUC has assembled has enabled it to engage with world specialists in those fruits whose monographs are being launched at this meeting.

ICUC has pioneered an approach which combines traditional scholarship and field experience about these fruits with an ability to make use of information technology. ICUC has introduced supporting databases on bibliographic references and on contact points for world specialists. The distribution databases keeps track of who has expressed interest in what features of a particular species or group, so that geographically dispersed people can make contact with others having similar interests. FRP aims for a ripple effect, so that the research outputs and benefits spread outwards from the initial project through a great variety of networks and contact systems in different countries and regions.

The short factsheets enable people to grasp the "essence" of the species, the "core" of the potential benefits - do you notice how related are these words to fruits? - fruits are deeply embedded in our various cultures and projects like this one should help to enhance appreciation of the nutritional and income-generating benefits of these tree fruits.

FRP projects are expected to produce results on paper which are scientifically excellent and well able to gain endorsement through peer review. But we appreciate that a variety of media are necessary to enable the farmers and processors to make best use of the new and freshly organised knowledge. So the project has also produced sample extension manuals and posters, which are simply written and can be adapted to other situations and translated into other languages.

FRP is most grateful to you in the audience for attending this launch of project outputs. We invite your comments, whether positive or critical, so

that the next phase of this work can be even better attuned to real needs in developing countries.

FRP thanks our hosts in Thailand and, most especially, the devoted team at ICUC and collaborating institutions whose results are here presented.

SECTION 1

OVERVIEW OF ICUC ACTIVITIES IN ASIA

ICUC ACTIVITIES IN ASIA

Dr. Nazmul Haq, ICUC, UK

ABSTRACT

Asia and the Pacific region has a great diversity in plant genetic resources and there is a tremendous opportunity to utilize the diversity for sustainably improved livelihood and the environment in the region. The potential contribution of underutilized crops to poverty reduction, improved human health, biodiversity conservation and natural resources management, empowerment of women and disadvantaged members of societies, and raising the food production to feed the World has been recognised by the meeting of the Global Forum on Agricultural Research GFAR.

ICUC's mission, objectives and global programmes and in particular activities in Asia have been discussed. Its major activity in Asia is Underutilised Tropical Fruits in Asia Network (UTFANET) which have nine member countries of the region and China has now agreed to join the network. The network has been endorsed by APAARI and now it has a regional office at PCARRD in the Philippines with a full-time coordinator funded by ICUC through its grants from Community Fund, UK. ICUC in partnership with FAO also launched a new network on Underutilised Traditional Vegetables for Asia and the Pacific Network (UTVAPNET). Ten countries are willing to join the network for collaborative research on production and marketing of underutilized traditional vegetables.

INTRODUCTION

Imbalances in world crop production in the last two decades, with serious food and fuel shortages in Africa and Asia, widespread poverty in Latin America and the Caribbean and the prospect of major changes in climate, have increasingly focused attention on the need to develop profitable enterprises to augment the major crops presently grown both in the developed and developing countries. Less than 30 of more than 13,000 known food crops and over 350,000 plant species produce most of the food needs for mankind. There are many plant species with significant food or industrial potential which remain underutilised through a lack of a coherent strategy for their evaluation and development. Humankind makes use of very few of the world's plant species for food and feed, shelter, industry, medicine and the improvement of the environment. The vast numbers of those unused and underutilised species represent an enormous untapped commodity resource which can help to meet the increasing demand for food and nutrition, energy, medicines and industrial needs. Some of these

untapped resources are either partly or fully domesticated but most remain wild and unevaluated. With the development of modern agricultural practices the potential of many of these commodity resources have been neglected. Some have been so neglected and the erosion of their gene pools so severe that they are often regarded as “lost” crops. Nevertheless, in much of the world underutilised crops and commodities play vital roles in the lives of the rural and urban poor, because they contribute to livelihoods, poverty alleviation and sustaining the environment. Many of these species are included in traditional subsistence farming systems particularly in marginal areas and, in many cases, these crops and commodities are life-savers for millions of resource poor people in regions where food and nutritional security are significant problems.

Interest in crop diversification around the world has evolved from a long history of plant introduction, in which crops have been evaluated far from their original areas of diversity. Many species have diversified further in their new areas of cultivation and now form the basis of staple food production and new production systems. However, with a few exceptions, agriculture in the tropics has suffered from a lack of mechanisms to introduce, test and understand less favoured species. Where such underutilised species have been tested, the available germplasm base has been too limited to achieve significant success. At the same time, the institutional framework in less developed countries has not had the capacity to extend to such crops locally or to integrate efforts internationally.

In recent decades, a number of scientific and economic interests have emerged to promote underutilised crops and commodities. A primary reason for this is that the crops are already found within the household and farming systems of small farmers vulnerable to food shortages and nutritional deficiencies, such as vitamins and proteins. Diversification within these systems, through the introduction of underutilised crops could lead to the production of new products which could be sold to raise income as well as satisfy subsistence needs. Underutilised crops are also given high priority in the Commodity Chain agenda of the Global Forum for Agricultural Research (GFAR). The regional fora of GFAR meeting, 2001-2002, have just completed the prioritisation of research areas and three of the GFAR’s fora have recognised underutilised crops as priorities for research and development.

The International Centre for Underutilized crops (ICUC) is an autonomous, non-profit, scientific and training centre. It was established in 1988 and is based at the University of Southampton, UK. The Centre was established to address ways of increasing the use of underutilised crops both for food, nutrition, medicinal and industrial products, and also for environmental improvement.

The mission of ICUC is to contribute to food security, improved nutrition and economic welfare of human beings through sustainable and increased economic production of food and industrial raw materials by developing and utilising the untapped biological diversity of underutilised crops.

The strategic aims of ICUC are:

- To develop new and underutilised crops and to foster their adoption to benefit both the producers within sustainable production systems and consumers in local, regional and international markets, and
- To conserve global biodiversity through its sustainable use.

In pursuing its goals, ICUC defines underutilised crops as "wild species that make a contribution to food and nutritional security or partially domesticated species which are grown in traditional agricultural systems and cultivated on a small scale and for which there is a potential for more extensive productive cultivation". They mitigate seasonal shortages of major staples and provide rural income, are often grown by women, are used in intercropping and mixed cropping systems and require little inputs. They are adapted to local environment and thus are tolerant to many biotic and abiotic stresses. Development of these species may need both R & D and introduction to new areas to attain their full potential. Research on underutilised crops is also likely to discover useful novel products.

The Centre programmes:

- Demand-led needs and opportunities for research and development of new and underutilised crops;
- Undertake research and development to promote the use of underutilised crops;
- Manage information on underutilised crops from any source and might range from technical to listings of individuals involved with research, product development, marketing and producers and others;
- Devise relevant training to provide professional and vocational development where needed and to develop skills needed for technology transfer.

ICUC's strategic multidisciplinary research activities are organised within a thematic framework of commodity groups which could include:

- Fruit and nut trees
- Vegetables, pulses, roots and tubers
- Cereals and pseudocereals
- Industrial, medicinal and aromatic plants
- Forage, fodder and energy crops

The ICUC has the commodity group “Fruits and Nuts” as its flagship programme and the name “Fruits of the Future” has been adopted as its title for Global programme.

Table 1 Summary of some recent Global ICUC initiatives

Region	Projects
<p>Global (Knowledge based information and dissemination)</p> <p>Human Resource Development</p>	<p>Information gathering, identification of research gaps and dissemination of information to policy makers, researchers, NGOs CBOs and farmers training for awareness for Fruits for the Future, Indigenous vegetables, Industrial crops including medicinal and aromatic species and commodities. The project is to enhance livelihoods and income generation.</p> <p>Preparation of specialist list of underutilised crops and commodities. The list includes specialists from both public and private sectors in Europe.</p> <p>Long-term and short-term training have been organised, particularly in Asia and the Pacific and Sub-Saharan Africa on utilisation of genetic resources, plant propagation methods, nursery management, community participatory indigenous vegetable production and household uses, in processing and products development and their business development.</p> <p>Farmer training on crop production and management have been organised in Asia and Africa.</p> <p>Appropriate training tools have been used in the training programmes.</p> <p>Ph.D training was also provided on specific problems of Underutilised crops.</p>
Asia and the Pacific (Research for development)	<ol style="list-style-type: none"> 1. Improvement of underutilised Fruits in Asia through Regional Collaborative Research (Linked with Network, UTFANET). 2. Indigenous vegetables for nutrition improvement in Asia through Regional Collaborative Research (linked with network, UTVAPNET). 3. Sustainable management and use of medicinal plants in the kitchen garden in Pakistan. 4. Assessment of diversity and use for income generation of homestead gardens in Bangladesh. 5. Oilseed tree crops in Africa. A project on diversity of the Shea nut tree in Ghana has already been completed.
Sub-Saharan Africa	<ol style="list-style-type: none"> 1. Improvement of indigenous vegetables in southern and eastern Africa (linked with network, SEANUC).
Cross regional	<ol style="list-style-type: none"> 1. Improvement of livelihoods from Non-Forest Produce through sustainable SMEs development in Zanzibar and Guyana. 2. Alternative crops for drug growing areas in Asia & Latin America.

ACTIVITIES IN ASIA

Over the years ICUC has been implementing the following Research and Development, Knowledge-base information and Dissemination and Human Resource Development Programme in Asia:

Research and Development

Improvement of Tropical Fruits

The Underutilized tropical Fruits in Asia (UTFANET) was established in 1995 by ICUC in partnership with APAARI, CSC, FAO and IPGRI. Countries participating include Bangladesh, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam. ICUC's major promotion of UTFANET over the years received a boost from the National Lottery Charities Board, UK and participating countries agreed on a 3 year (2000-2003) workplan:

- Farmer's participatory survey (including marketing)
- Characterisation of jackfruit, pummelo and mangosteen
- Propagation and distribution of planting materials (especially through farmers' nurseries)
- Identify the water and nutrient requirements of pummelo and jackfruit
- Training of scientists and farmers (for propagation)

Diversity of jackfruit and pummelo was studied in Bangladesh and Nepal. Both vegetative and *in vitro* (tissue culture) propagation methods of jackfruit and pummelo have been established.

Jackfruit product development

ICUC funded a project to the Bangladesh Council of Scientific and Industrial Research (BCSIR) to develop products from jackfruit. Several products including toffees, biscuits, drink, dry pulp in syrup was successfully produced. A field trial was carried out and good acceptability of products among children was found. ICUC in collaboration with BCSIR arranged the project seminar, followed by an exhibition of products at BCSIR. Local entrepreneurs have contacted BCSIR to market biscuits, toffees and drinks.

Fruits for the future: A major project entitled fruits for the future has been initiated by ICUC in collaboration with IPGRI and ICRAF to overcome the constraints of lack of access to appropriate information on propagation and

production methods, post-harvest, processing and marketing. ICUC has commissioned specialists in Sri Lanka and India to produce monographs and extension manuals on Tamarind and *Ziziphus*.

Homestead farming

ICUC funded a study on the diversity of homestead farms in Bangladesh. The project involves three different ecosystems and the objectives are: (a) to identify superior types of species through farmers' survey and evaluation, (b) multiplication of these species and (c) on-farm vegetable seed production, to rehabilitate home farm systems.

Improvement of safflower in Pakistan

A project was implemented by ICUC in collaboration with BARANI Research Institute in Chakwal to select suitable types to grow under rain-fed conditions. Two lines were selected for seed multiplication and for further trials.

Knowledge-based information and dissemination

In addition to UTFANET, ICUC (in collaboration with FAO) has formed Underutilised Traditional Vegetables for Asia and the Pacific Network (UTVAPNET) at a regional workshop on Conservation and Use of Traditional Vegetables, held in Los Banos. The network will link with different initiatives in the region dealing with collection and their conservation.

Documentation

ICUC continues to expand its database on underutilised crops which includes much generated information from the Asian activities of its commodity groups. The information includes botanical, agricultural and product data on underutilised plant species that is not easily accessible elsewhere.

Publications

Eight published and two are in the press. These publications are mostly proceedings of the conferences and workshops organised by ICUC in the region.

Conferences and workshops

ICUC has organised workshops on its different commodity groups of underutilised species in the following countries of the region:

Bangladesh, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand.

Human Resource Development

ICUC funded studentships for Ph.D training to Bangladesh and Nepal and in collaboration with partners arranged and financed training programmes in:

- Malaysia - Crop improvement (for 4 years)
- Thailand - Production Management of Tropical Fruits (Practical training)
- India (jointly with IPGRI) - UTFANET
- Bangladesh - Propagation methods of Jackfruit and Pummelo
- Philippines - Propagation methods of Mangosteen

It is hoped that the participants of this meeting will share our knowledge and hopefully will come out with some proposals for higher utilisation of underutilised crops to alleviate poverty. This would enable us to develop a collaborative research programme to be launched in Asia. This, I am sure, will develop a close collaboration on research on UCC between ICUC and all stakeholders in Asia.

FRUITS FOR THE FUTURE

Ms. Angela Hughes, ICUC, UK

The objective of the Fruits for the Future project is to provide access to information on various aspects of production, harvest, postharvest, processing, utilisation and marketing of Underutilised Tropical Fruit Trees (UTFTs) and also to promote and generate awareness of these species. Information on production methods, varieties, management, harvesting, postharvest etc. can provide farmers with the tools they need to increase their income, food and nutrition security and sustainable livelihood. However, the information itself must first be made available and then the pathway of information dissemination forged. Through the research, review and gathering process, areas of research can be identified where information is lacking and priorities for future research can be established.

The project has many potential beneficiaries. Farmers are given access to relevant information, for example, methods for increased production and better quality fruits, in simplistic and understandable formats. Extension workers, NGOs and CBOs are provided with information at different levels for their use and understanding, and for use as a tool to educate others. Traders and processors from the private sector can benefit from the general information provided on each crop to create awareness. Meetings such as these create awareness and promotion to policy makers which has an effect on all beneficiaries and can help to provide good, sound information for making policy changes and strategies for future projects.

The benefits of growing the trees themselves can be large. Fruit trees are often grown in small plots, homesteads and on waste ground; they are not usually the primary source of income. UTFTs are a relatively long-term investment and can provide additional income to farmers of other crops. In some cases it is not the amount of fruit or product provided by the tree that is important, but the season, or time of year the fruits can be harvested. Unlike many field crops, fruit trees often bear fruit for either an extended harvest season or more than once a year. This spreads the product allowing income for a longer period. Fruit trees may also bear fruit at a different time of year when other crops are finished. This is important, particularly for women, to provide household food security during the 'dry' season. Many indigenous fruits have a highly valued natural composition and also provide an alternative source of vitamins and minerals. They complement the staple foods and provide different benefits from those foods already consumed. It is the combination of a variety of different foods which provides a healthy diet. Trees are a long-term investment and if they remain productive can help towards a sustainable livelihood.

HISTORY

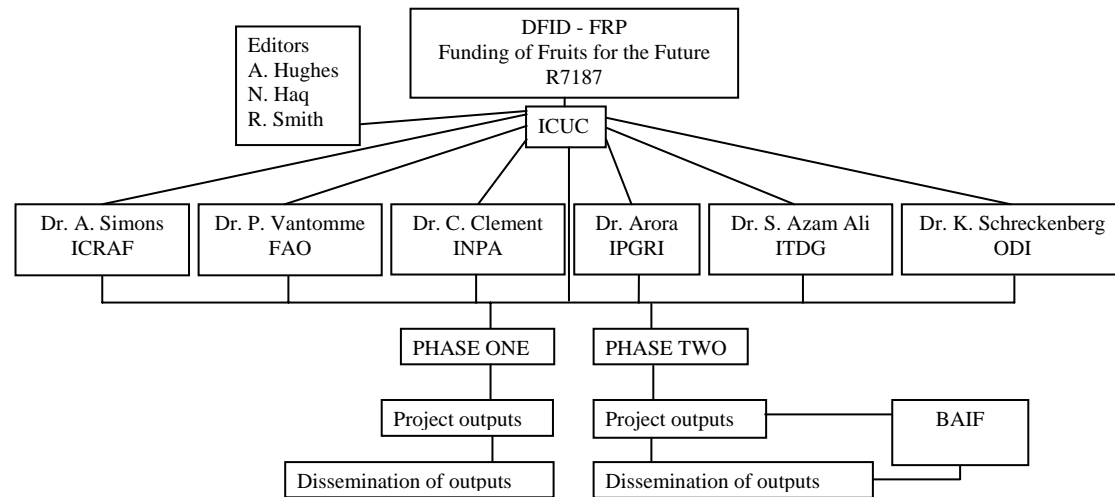
The Fruits for the Future project was established out of demand for up-to-date research information on different aspects of production, propagation, harvest and postharvest of underutilised tropical fruit trees. At a conference in Southampton in 1996, on Domestication, Production and Utilisation of New Crops, a number of issues were raised concerning 'access to information on varieties, propagation and management methods' particularly for local farmers, also public awareness and promotion of new crops. The exchange of information is not however a one-way process, much information can be obtained from traditional farmers who have been utilising such species for generations. This kind of information is also very important when establishing an information-based project, to gauge the level and type of information required. Through ICUC's work in the past and the work of project partner organisations, information from participatory surveys including farmers, trade workers and small-scale entrepreneurs was collated and used to establish the project. The necessity for a monograph series, in addition to extension materials, continued to be a point of discussion through successive regional meetings of UTFANET, SEANUC and MESFIN and also meetings of ICRAF, IPGRI and FAO. So, in 1998 a project initiation meeting for the Fruits for the Future project was well founded. The project proposal was accepted by DFID-FRP and the project began in Nov. 1998.

PROJECT STRUCTURE

An Editorial Advisory Committee (EAC) was established at the project initiation meeting. The committee is made up of 9 members including representatives from partner organisations and 3 editors from ICUC. The EAC are responsible for assistance in the editing of the project outputs, particularly from a technical/content perspective. They also advise on the general running of the project and project activities for phases I and II. All partners assist in the dissemination of project outputs.

ICUC has taken on the Fruits for the Future project with assistance from international partner organisations, ICRAF, IPGRI and FAO, and NGOs, BAIF and ITDG. A number of individuals are also represented on the EAC. The EAC representatives have many years' experience in their field and have much knowledge in the areas of agroforestry, food and nutrition security, genetic resources, development, processing and utilisation of fruit trees. The knowledge base is broad and through collaboration between such organisations, it is hoped that duplication of information is minimised and dissemination is maximised. BAIF is involved in impact assessment and uptake of information from the project, through training workshops and co-publication of extension materials in India. Such workshops and publications are planned for Africa in collaboration with ICRAF.

Project Structure



SPECIES

Fruits for the Future started out as a 3 year project to produce monographs, extension materials and information in different formats on 9 species of tropical fruit trees. Priority tropical fruit tree species were discussed and identified at regional meetings involving project partners and other organisations. A final selection of species was made during the project initiation meeting based on a number of specific criteria including priority settings by so-called target audiences such as farmers, national institutions, experts and through market surveys, existing and planned monograph works, regional/global importances and primary purpose of the species, eg, income generation, food security etc. As a result of this, species and authors were selected - *Tamarindus indica*, *Ziziphus mauritiana*, *Annona* spp, *Dacryodes edulis* and *Adansonia digitata*. During the course of this project, ICUC gained funding through DFID-FRP to produce outputs for a further 8 species (5 books), which were also identified at the start of the project. Jackfruit (*Artocarpus heterophyllus*) has already been included in ICUC projects through the UTFANET and mangosteen (*Garcinia mangostana* also *G. cola/indica/nitida*) also prominent in the Asian region, has been gaining importance in the international market. The other species are *Ricinodendron heudelotti*, *Strychnos cocculoides* and *Pouteria campechiana*. These are phase II species.

PROJECT OUTPUTS

Monographs



The monograph series provides a review of current literature and research on different aspects of the species from basic botanical information, plant genetic resources, propagation, production, harvesting and processing to uses. The monographs are very detailed and in some cases, very technical. The target beneficiaries are primarily researchers and students, though policy makers, traders, NGOs and some farmers may also find them interesting. The monographs not only provide information but it is hoped that they will stimulate thought amongst researchers and identify areas of research which may be lacking. The monograph series is being published in English (*Dacryodes* only, in French) at present, but ICUC will be seeking funds for the translation and publication of these and the other publications in other, local languages.

Extension Manuals

Extension manuals provide a more detailed review of the commonly used methods of propagation, management, harvesting, postharvest and utilisation, and are illustrated with diagrams. They are produced for use by extension workers, NGOs and CBOs, some farmers may also find them useful.

Database

The database is a mechanism and tool to store information which has been collected throughout the project. Originally set up as a bibliographical database, it is being expanded to include information on the production, processing, marketing and utilisation of the selected fruit tree species. ICUC also holds information on species specialists and various organisations (GO, NGO, CBO and private sector) interested in underutilised crops.

Website

The Internet has become increasingly accessible in the last few years and is an excellent medium for the promotion of UTFTs. It is a cheap dissemination method and bypasses many of the logistical problems of producing and distributing hard copy publications. The information is dynamic and can be updated regularly. One of the major drawbacks of this system however, is that the user needs a computer with internet access, and for this reason, hard copy publications remain an important and necessary means of information dissemination. The project website currently contains bibliographical information on the first phase species and links to the factsheets. Over the next year, the site will be restructured and links to all project publications will be available. The database will also be accessible

through the site. The database and website will be discussed further in the 'Information Dissemination' session this afternoon.

CD ROM

Many organisations are currently producing CD ROMs. One of the reasons for this is to overcome the internet access requirements necessary to download information. CD ROM is also a tool which allows storage of large quantities of information that cannot be held on the more commonly used floppy disk. It allows the display of interactive information such as searchable databases. In addition to its database, ICUC also plans to distribute interactive copies of the monograph series on CD ROM. Publication of hardcopy will continue but all forms of media are being explored.

Factsheets

Factsheets are being produced for all project species. They provide general background information on the distribution, climate requirements, propagation, economics, processing, marketing and uses. The target beneficiaries are the general public, policy makers, scientists, extension organisation, traders, processors and any other interested parties.

Training

Following the publication of phase I outputs, it was necessary to ensure that not only were the publications being distributed, but that the information was being provided to all beneficiaries and that it was being used. As a result, in collaboration with BAIF in India, the first set of training courses have been carried out for farmers and extension officers. The training courses were on Tamarind and Ber: basic background information, varieties, propagation methods, harvesting, postharvest, and utilisation. Training courses were held in 3 different regions in 3 different (local) languages. Farmers' manuals and posters have been published in 4 languages (Marathi, Gujarati, Kannada and English) and distributed to all participants; further copies are also being distributed. The response from the workshop has so far been positive. BAIF currently has orchards of Tamarind and Ber trees which are available to farmers requesting them.

PROMOTION OF UTFT

The promotion of UTFTs is essential for their development. Promotion and awareness creates demand for the product. Methods of promotion are many

and with increasing technology, such methods are increasing. ICUC, through the Fruits for the Future project, is promoting UTFTs primarily through publication. As discussed above, a large number of publications are being produced, in a number of languages and at different levels, for maximum impact. Attendance at meetings and conferences is also an important part of promotion. ICUC representatives have attended many such meetings and delivered papers on the topic of UTFTs and underutilised crops as a whole. Training courses and workshops provide a forum to discuss UTFT. Participatory involvement of local farmers, producers, traders etc. also provides a very clear and direct pathway for promotion and distribution of information. Further methods of promotion used by the project are publication of articles in newsletters, magazines and journals, review of publications and collaboration with specialists/experts, organisations and institutes interested in the selected species.

UPTAKE AND IMPACT ASSESSMENT

The success of a project is not necessarily measured by whether it has been completed or the outputs produced. In the case of the Fruits for the Future project, success is measured by the uptake, utilisation and impact of the outputs. The uptake of information is dependent to some degree on the promotion of both underutilised tropical fruit trees and the project itself, which have been discussed above. The uptake of information is also being facilitated through our partner organisations and through training workshops such as those carried out by BAIF. One of the best mechanisms to ensure uptake and impact of information is to encourage follow-up projects, particularly in the areas highlighted in the monographs as 'lacking'. It is hoped that such projects may result from this meeting.

One such project, which has been established from phase I of the Fruits for the Future project is the 'Development of a model to forecast the adaptation of tropical fruit tree species to different habitats'. Using GIS, the biophysical limits of each species can be mapped for their expansion and impact on socio-economic and cultural aspects in sub-saharan Africa. This also has implications for climate change. The study has begun using phase I species, however, additional species, from phase II may also be included. Once the model has been developed, it is hoped that it will be transferable for other species of fruit tree and also for underutilised crops as a whole.

Publication Review

The Tamarind monograph has been reviewed in a number of Journals, Newsletters etc. and most have been very encouraging. These reviews have generated a great interest in our publications. A large number of requests

have been received, particularly from Africa, due mainly to the review in the Spore magazine produced by CTA, which is widely distributed throughout Africa. Many of those requesting information, belong to small NGOs or research institutes. The other species in the series will also be promoted in journals etc.

ICUC-UTFANET AND ITS ROLE IN ASIA

Dr. Merilyn Rondolo, ICUC-UTFANET c/o PCARRD

UNDERUTILISED TROPICAL FRUITS IN ASIA NETWORK (UTFANET)

Underutilised Tropical Fruits in Asia Network (UTFANET) is a part of the Fruits and Nuts programme of the United Kingdom-based International Centre for Underutilised Crops (ICUC). UTFANET also forms part of the ICUC's Global Programme called "Fruits for the Future". The initial setup was funded by the UK Department for International Development (DFID).

UTFANET is a network of fruit-producing countries in Asia with Bangladesh, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam as member countries. China has also requested membership.

UTFANET is endorsed by the Asia Pacific Association of Agricultural Research Institutions (APAARI) and funded by Community-Fund of the United Kingdom, ICUC and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD).

MISSION

Realising the immense potential availability of a highly diverse fruit species and impending threat to tropical fruit trees in Asia, UTFANET is set to accomplish its mission of:

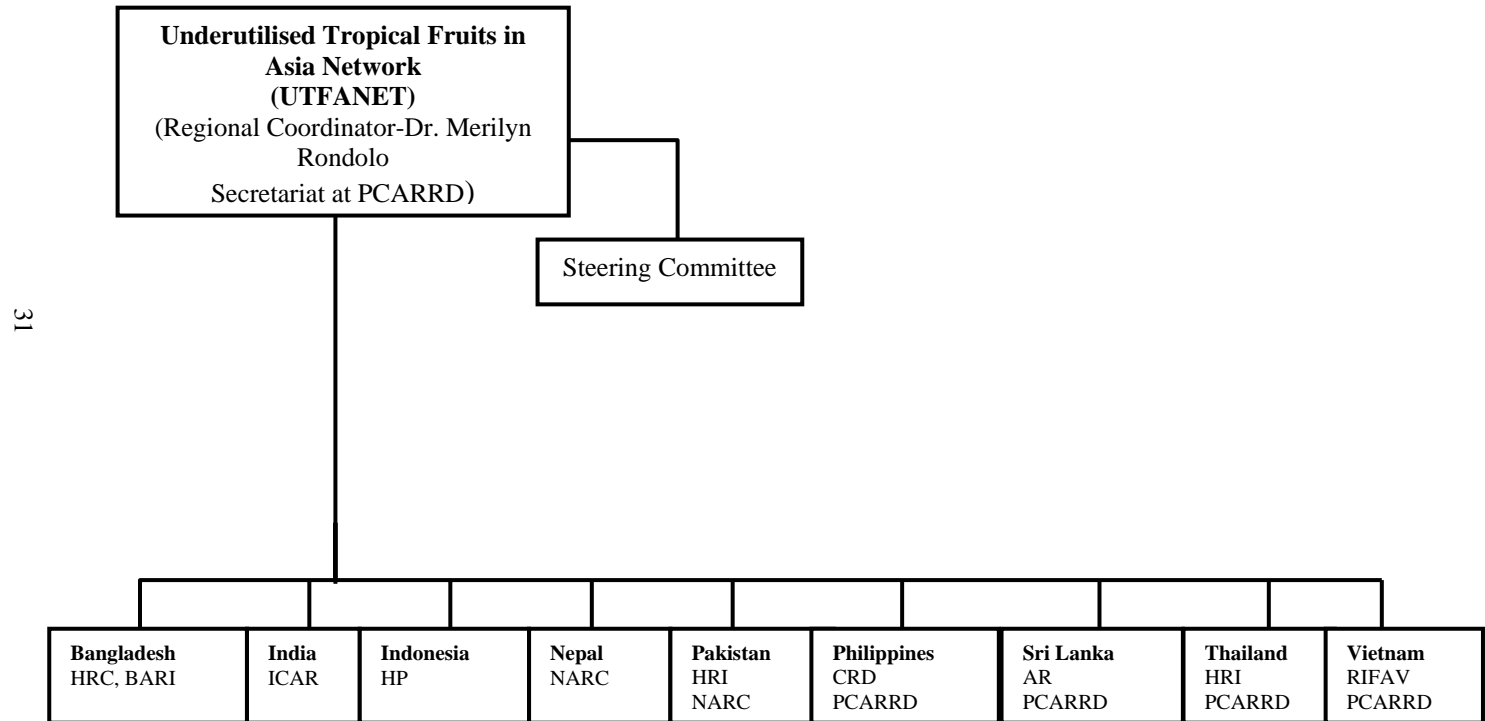
Improving the economic, social and nutritional status of people in the region through increased production and utilisation of underutilised tropical fruits.

ORGANISATION AND STRUCTURE

A Steering Committee composed of representatives from nine member countries governs UTFANET (please see Figure 1). Its duties are to:

- approve projects, programmes and budget of the network
- monitor and assess the progress of network activities
- report to participating countries and donor agencies

Figure 1 UTFANET organisational structure



ACTIVITIES OF UTFANET

Sri Lanka
AR

UTFANET has identified eight activities. These include the following:

- information gathering and dissemination
- exploration, collection and conservation of germplasm
- development of appropriate propagation and production methods
- development of fruit based cropping systems
- improvement of post-production handling, transportation, processing and marketing
- promotion of collaborative research
- organisation of training workshops, exchange of technical visits
- establishment of links with other networks working on tropical fruits.

PRIORITY SETTING OF FRUITS

Priority setting has been guided by farmers and experts on fruit trees and markets in order to determine the priority species for the region. The results of farmers' participation were discussed in two session-workshops involving all the stakeholders. They divided the species into two groups for initial research and development.

Group 1: Jackfruit, pummelo, longan, mangosteen, ber and guava

Group 2: Lime, annona, emblic, salak, carambola and durian

It should be noted that priority setting is a continuing activity because priority fruit species change over time in any geographic location.

The participants agreed on a three-year (2000-2003) work plan, which was:

- farmer's participatory survey (including production, uses, processing and marketing)
- characterization of jackfruit, mangosteen and pummelo
- propagation and distribution of planting materials (especially through farmers' nurseries)
- identification of the water and nutrient requirements of pummelo and jackfruit
- training of scientists and farmers (for propagation)
- documentation/data-base development
- information dissemination through publication and distribution of newsletter, flyers, factsheets, and training/extension/information materials on jackfruit, mangosteen, and pummelo

ACHIEVEMENTS

The participating member countries of UTFANET accomplished the following:

Research and Development

Farmers' participatory survey

Accessions of jackfruit, mangosteen and pummelo were collected, observed, characterised and evaluated. Elite lines from among these accessions were already identified in member countries as follows:

Jackfruit

All member countries are working on jackfruit. More than half (6 member countries) of the member countries have already identified elite lines of jackfruit. Being the centre of jackfruit diversity in the region, India had the highest number of identified elite lines followed by Bangladesh and Pakistan (please see Table 1).

Mangosteen

Five member countries are working on mangosteen and these are India, Philippines, Sri Lanka, Thailand and Vietnam. India has identified one elite line of mangosteen and the other countries are in the process of identifying elite lines from their accessions. Philippines has the most accessions followed by Thailand and Vietnam (please see Table 1).

All member countries, except for Indonesia are working on pummelo. Among these, Bangladesh, India, Nepal, Philippines and Vietnam have already identified elite lines from their accessions. Vietnam has the most elite lines (41) followed by India and Bangladesh. Philippines has the least (one elite line) (please see Table 1).

Table 1 Collection, characterisation, evaluation and selection of promising lines in Year 2

	Jackfruit		Pummelo		Mangosteen	
	<i>Collection characterization evaluation</i>	<i>Selection</i>	<i>Collection characterization evaluation</i>	<i>Selection</i>	<i>Collection characterization evaluation</i>	<i>Selection</i>
Bangladesh	70	10	73	5	-	-
India	53	33	40	8	2	1
Indonesia	18	10	-	-	-	-
Nepal	16	6	13	6	-	-
Pakistan	10	8	6	NY	-	-
Philippines	10	4	12	1	10	-
Sri Lanka	42	2	21	-	2	2
Thailand	58	1	36	NY	7	NY
Vietnam	12	8	50	9	-	2

NY Not yetPummelo

PROPAGATION, PRODUCTION AND DISTRIBUTION METHODS AND THE SUPPLY OF QUALITY PLANTING MATERIAL TO FARMERS

Some member countries have already developed appropriate propagation techniques for jackfruit, mangosteen and pummelo while the rest of the member countries are still developing theirs. The following are preliminary results of propagation studies on the three priority species:

Jackfruit

All member countries except for Vietnam and Pakistan are developing appropriate propagation techniques for jackfruit. Bangladesh, Indonesia, Nepal and Philippines are working on both *in vitro* and vegetative propagation. The rest of the participating countries are working on vegetative propagation only (please see Table 2). Preliminary results indicate that jackfruit was propagated successfully through:

- epicotyl grafting using less than one month old rootstock and scion and approach grafting using one-year old rootstock in India
- cleft grafting in Mid-November in Nepal.

Moreover, initial results of *in vitro* propagation studies in the Philippines showed that shoot tip and embryo responded positively to RIARC 1 and 2 media.

Mangosteen

Three member countries are developing appropriate propagation techniques for mangosteen. Philippines is working on *in vitro*, vegetative and seed propagation and Sri Lanka and Vietnam on vegetative propagation only (please see Table 2). Initial results indicate that mangosteen was propagated successfully through inarching, cleft and wedge grafting in Sri Lanka.

Mangosteen is of increasing economic importance in Thailand and the demand is for high quality fruits. One method of raising productivity is fertigation - the supply of dissolved fertiliser via irrigation. Results of fertigation studies in Thailand indicate that fertigation was better than traditional fertilisation. Fruit yield has increased and the cost of fertiliser on a per hectare basis was reduced by almost 16 percent (please see Table 3).

Table 2 Propagation studies on jackfruit, mangosteen and pummelo among UTFANET member-countries

Country	Jackfruit (n=7)		Mangosteen (n=3)			Pummelo (n=7)	
	<i>In vitro</i> (n=4)	Vegetative (n=7)	<i>In vitro</i> (n=1)	Vegetative (n=3)	Seed (n=1)	<i>In vitro</i> (n=2)	Vegetative (n=6)
Bangladesh	x	x	NA	NA	NA	NC	x
India	NC	x	NA	NA	NA	NC	x
Indonesia	x	x	NA	NA	NA	NA	NA
Nepal	x	x	NA	NA	NA	NC	x
Pakistan	NA	NA	NA	NA	NA	NC	x
Philippines	x	x	x	x	x	NA	NA
Sri Lanka	NC	x	NC	x	NC	NC	x
Thailand	NC	x	NC	NC	NC	x	x
Vietnam	NA	NA	NC	x	NC	x	NC

n number of countries working on the propagation of the three fruits

NA research not assigned

NC research assigned but portion not conducted

Source: 2001 Progress reports and personal communications with NCs

Table 3 Comparison of traditional fertilisation and fertigation on yields and fertigation cost (average in 2 years)

Treatment	Fertiliser rate/tree N-P ₂ O ₅ -K ₂ O	Number of fruit/tree	Fruit weight (g)	Yield/tree (kg)	Fertiliser cost/ha/year (US \$)
Traditional fertilisation	880-1200-1300	228	100	22	422
Fertigation*	550-300-1000	504	92	43	357

*Fertigation rate was based on judgment of tree NPK status, crop removal and soil nutrients availability.

Source: Panjaporn Lertrat, 1999. Horticulture Research Institute Newsletter: 12 (2-3): 4-6.

Pummelo

With the exemption of the Philippines and Indonesia, all participating countries are working on developing appropriate propagation techniques for pummelo. Thailand is working on both *in vitro* and vegetative propagation; Bangladesh, India, Nepal, Pakistan and Sri Lanka on vegetative propagation only and Vietnam on *in vitro* propagation only (please see Table 2). Results so far indicate that in Nepal, pummelo was successfully propagated through veneer grafting.

Quality planting materials of jackfruit, mangosteen and pummelo were likewise produced and maintained in various gene banks and nurseries of participating countries. Some of these planting materials were distributed to walk-in growers and training participants. Some were also used in field planting and trials. Rootstock production to support propagation studies is continuously done among member countries.

Information gathering and dissemination

Data/information from various sources has been organised and added to existing ICUC-developed databases, published and disseminated. UTFANET publications include:

- Annotated Bibliographies of Jackfruit, Pummelo and Mangosteen” (Anon 1997) - a comprehensive and useful reference material for scientists and those who are working on the three underutilised fruit tree crops
- Factsheet on jackfruit (under review) - contains information on: taxonomic and morphologic characteristics, habitat and species distribution, site requirements, economics, propagation and uses
- Leaflet-contains information about mission, goal, objectives and activities of UTFANET
- Newsletter - contains regional R & D highlights, training and events on underutilised tropical fruit crops in the region
- Proceedings of symposium/workshops and meetings - contains papers presented and decisions/agreements arrived at during meetings/workshops
- Poster-contains appropriate production and processing technologies related to jackfruit, mangosteen and pummelo.
- Training reports - contain modules of jackfruit and mangosteen propagation, jackfruit processing, list of training participants and results of post-training evaluation.

UTFANET uses printed materials, radio broadcasts, exhibits and the Internet to facilitate dissemination of information and technologies to reach as many users as possible.

UTFANET publishes its own factsheets, leaflets and newsletters and has also conducted a product exhibition on jackfruit in Dhaka, Bangladesh.

In collaboration with ICUC, UTFANET has finally created its own website - <http://www.civil.soton.ac.uk/icuc/utfanet> and published the bibliographies on jackfruit, mangosteen and pummelo and the proceedings of various training courses and meetings.

In collaboration with PCARRD and with various Philippine radio stations - DZMM, DZRB and DZRM - the Regional Coordinator discussed the nature, mission, objectives and activities of UTFANET and the use of underutilised tropical fruits as alternative reforestation species and agroforestry crops in the Philippines. The Regional Office has received several inquiries about sources of quality planting materials of jackfruit for the establishment of jackfruit-based farming systems in some parts of the Philippines.

Human Resource Development and Technology Transfer

UTFANET has organised yearly meetings of the Steering Committee. UTFANET also conducted non-degree training courses and provided degree training to scientists in the Asian Region. These were:

- establishment, cultivation and management for orchards in Vietnam
- jackfruit propagation in Bangladesh
- jackfruit propagation and nursery management in the Philippines
- mangosteen propagation and study visit to fruit growing areas in the Philippines
- rootstock plant production, vegetative propagation and nursery management in India
- crop improvement training in Malaysia
- practical training on the production management of tropical fruits in Thailand
- degree training, Ph.D. (so far two scientists).

In collaboration with IPGRI, UTFANET provided a regional training course on the Conservation and Use of Tropical Fruits in Asia in India.

WHAT ELSE SHOULD UTFANET DO?

With the assistance of various organisations and member countries in the region, UTFANET was able to achieve significant milestones. These milestones propel us at UTFANET to go on and accomplish our mission. While accomplishing our mission, we make sure we focus on the big picture, which we have already painted in 1995 when UTFANET was formed. That big picture contained:

- a fruit platter that has a variety of fruits on it for consumers around the globe to enjoy
- gatherers and small hold growers who get continuous flow of cash and supplementary food from tropical fruits
- plantation owners who are satisfied with proceeds from their produce
- women and children in Asia whose nutrition is greatly improved
- tropical fruits and fruit trees that serve as inspiration for artists and those who seek refuge from the many pressures of life
- fruit-based farms and home gardens in Asia
- tropical fruit trees as indispensable components of the region's environment.

I wish to thank Dr. Haq for his invaluable help in preparing this paper.

Distinguished guests and participants, thank you and I wish you three fruitful days in Bangkok.

SECTION 2

UPTAKE OF OUTPUTS FOR PHASE 1, FRUITS FOR THE FUTURE

INFORMATION DISSEMINATION

Mr. Oliver Bromley, ICUC, UK

WHAT WE HAVE

ICUC has a data base containing information on various topics structured relationally so that queries can be constructed at will from any of the tables. The subject matter can be ordered in different ways or filtered to include only a sub-set of the total data. There is information on the range and cultivation of plants as well as postharvesting, processing and marketing.

CATEGORISATION OF CONTENT

This can be botanical, by species or by projects that may cut across species and area distinctions. Another way to classify is by commercial value or by the popularity of the data eg. frequency of access of web pages. The role of the user is also important as a grower has different needs to a trainer, trader or research scientist.

HOW WE DISSEMINATE

Paper copy is distributed on request: such things as specialist lists and bibliographies or training course materials such as cultivation guides. In the future we'll be looking more to CDs and an interactive web site to supplement paper distribution.

IT TECHNOLOGY USED

In the main, most of our work is carried on high specification PC's using an NT server as backup and for web deployment. Issues over operating system and package choice have largely been dissipated by the dominance of Windows and Microsoft Office.

- Operating Systems: NT Server, Windows
- Office Suites: MS Office
- MS Office: *.DOC, *.HTM, *.XML, *PPT, *XLS, *.MDB
- Office Versions: 97, 2000, 2002/XP

VARIOUS FORMATS

The data is disseminated in various formats. The cheapest dissemination is the website because it has low maintenance costs and runs 7*24 providing a service globally. If information needs updating this can be done at short notice and there is no loss of materials as sometimes occurs when paper copy goes out of date.

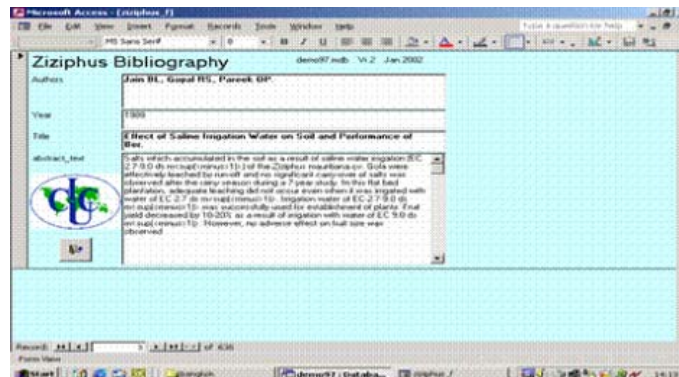
- Paper: Factsheets, Newsletters, Monographs, Posters, Training Manuals, Extension Materials
- Digital Images: PDF, BMP, JPG, GIF, TIF, PNG
- Digital Documents: DOC, HTML, Access db, XML, PDF

DATABASE ACCESS 97 DEMONSTRATION

A demonstration of some of the capability of the database is available as an Access database for download at:

<http://www.civil.soton.ac.uk/icuc/demo97.mdb>

It consists of a Bibliography, with abstracts. Save it locally and then run it using MS Access.



PROMOTION OF UNDERUTILISED FRUIT CROPS

Dr. Narayan G. Hegde
BAIF Development Research Foundation, India

PROBLEMS OF THE RURAL PEOPLE

With the increasing population pressure, rural India is facing a serious challenge of food security, unemployment and environmental degradation. About 65% of the Indian population is presently living in rural areas and 85% of these rural families are dependent on agro-based activities for their livelihood. The important natural resources contributing to their income and employment are land, water, forest, vegetation and livestock. Among them, land is the primary resource required for initiating agricultural production activities. Water contributes to the productivity of land. Forests provide fodder, fuel, timber, non-wood forest produce and medicinal herbs, which are required by most of the rural families. Apart from providing various outputs, forests have also been playing a significant role in maintaining the ecological balance, improving the micro-climate and recharging the ground water, which in turn help to improve the agricultural production and ensure safe drinking water. Livestock has been providing supplementary income through milk, wool and meat, while supporting agriculture through the supply of manure and bullock power.

In the absence of other sources of employment, the growing rural population has been over-exploiting these resources without taking any responsibility to conserve their productivity. As a result, these resources have been heavily depleted during the past 4-5 decades. Sub-division and fragmentation of lands have further reduced the land holding of small farmers. Unable to meet the basic needs from their own lands, the smallholders have been depending on the community lands and forests. In the process of a long struggle to ensure their food security, conservation of these resources has been overlooked. Presently, over 35-40% of the total land area classified as wastelands is remaining idle, posing a serious threat to the eco-system. Over 65% of the rainwater runs off the field, causing heavy soil erosion, siltation of riverbeds and water reservoirs. Over 55% of the scarce forests are devoid of vegetation, which has further accelerated soil erosion and surface run-off of rainwater. Over 85% of the livestock are under-productive, causing economic drain to their owners. In such a situation, the rural families are deprived of self-employment opportunities, resulting in severe poverty. Presently, over 40-50% of the rural population is living in poverty, unable to meet its basic needs for survival.

SCOPE FOR TREE-BASED FARMING

In the absence of potential industrial development in rural India, the issues of poverty and food security will have to be tackled by developing these degraded natural resources, while providing sustainable employment to the poor. In this situation, tree-based farming offers excellent opportunities because of several advantages. The major advantages of tree-based farming are the ability of tree species to withstand harsh agro-ecological conditions such as moisture stress and tolerance to various degrees of salinity. Trees have the ability to establish on poor soils and improve the soil productivity through deep root system, recharging of ground water, recycling of mineral nutrients from lower profiles of the ground, contribution of organic matter and improvement of micro-climate by providing shade and checking the wind velocity. However, such programmes are presently not very popular mainly because of lack of awareness, technology and resources.

Among the tree-based farming practices, the most popular schemes have been the establishment of forestry species for biomass and raw materials for paper and pulp industries. These schemes were launched by the Forestry and Environmental Ministries who are concerned about environmental conservation, to provide alternatives for deforestation of natural forests and bio-spheres and to meet the basic needs of fuel, timber and other forest products. Ecological imbalance and global warming being the major problems, international fundings were easily available for launching such afforestation programmes. In India, the National Commission on Agriculture constituted by the Planning Commission in 1976 recommended promoting the cultivation of fodder and fuel-wood species, on community wastelands and village woodlots to benefit the poor. Accordingly, the government agencies were promoting these species on common lands. The paper and pulp industries encouraged the cultivation of different species for industrial raw materials. Many plantation firms came up with a scheme to establish tree species for valuable timber production. Most of the forestry promoting agencies had selected such species based on the demand for the output and not necessarily to maximise the returns. As a result, many of these schemes could not attract the farmers and ended in failure.

It was observed that the income from the plantations of fodder or fuel-wood species such as *Leucaena*, *Gliricidia* and *Acacias* was significantly low as compared to the species such as *Eucalyptus*, *Casuarina*, *Melia*, bamboo, etc., which had timber value. This was evident because a ton of wood as fuel could fetch only Rs.500-800 (USD 1 = Rs.48), while as a raw material for paper or pulp, it could fetch Rs.1000-1200. If the same wood was used as round timber or for furniture, the value would increase to Rs.1800 to Rs.3000/ton. Thus with all the best intentions and financial resources, many such schemes launched by various organisations could not succeed. In fact they confused the farmers.

PREFERENCE FOR FRUIT CROPS

Apart from such forestry programmes, several initiatives were taken to promote fruit and non-timber tree species by the Ministry of Agriculture and some non-government agencies, which received a good response from the farmers.

The reasons for active participation of the farmers in these horticultural schemes were:

- higher economic benefits and regular income for a long period
- easy marketability of the produce
- scope for combining food crops and other arable crops with fruit production
- scope for shifting from low input, uneconomic agricultural production to assured sustainable farming systems.

In a programme launched by BAIF, it was originally intended to promote energy plantations by establishing tree species such as *Leucaena leucocephala*, *Acacia auriculiformis*, *Dendrocalamus strictus*, etc. but the poor tribal families were reluctant to plant these species, because of the following concerns:

- lack of information about the economic benefits
- non-availability of good quality planting materials
- lack of market outlets and outdated Tree Acts which hamper the felling, transportation and marketing of wood
- long gestation period.

Some of the tribals owning their lands near the forests felt that there was no need to grow fodder and fuel-wood trees as they had easy access to the forests. On the contrary they were prepared to establish fruit trees. Among the fruit trees, their main preference was mango, as they had some experience of working in mango orchards. Like them, most of the farmers preferred fruit species instead of forestry plants. However, they did not have any specific demand for any particular species and their preference was influenced by their limited awareness and partial knowledge about various species. The most popular fruit species grown in the tropics are mango, citrus, sapota, banana, guava, cashew, litchi, grapes, pomegranate, etc. These crops have been very well domesticated and developed through extensive research on germplasm selection, breeding of new varieties, standardisation of cultivation practices by using optimum quantities of manures, fertilisers, water and plant protection inputs. These fruits have good demand in the market and hence the marketing network has been very well established. Among these fruit crops, banana, citrus, sapota and grapes require good quality land as well as assured source of water for irrigation. Crops like guava and pomegranate can grow on marginal quality lands but require assured irrigation to enhance fruit production. Mango

and litchi prefer good quality land, while the cultivation of cashew is confined to coastal region.

Underutilised Fruit Crops

There are large areas of marginal and wastelands, which are not suitable for cultivation of the above species, either due to poor quality soil or lack of water resources. Such lands are suitable for underutilised fruit crops such as ber, tamarind, custard apple, Indian gooseberry, etc., which are in good demand but these crops are not very popular among the farmers.

The reasons for poor popularity of underutilised fruit crops are:

- a. lack of awareness about the economic benefits
- b. non-availability of good quality planting materials
- c. lack of technology to reduce the gestation period and enhance the fruit production
- d. poor marketing network
- e. lack of technology for value addition, through processing.

Most of these lesser known fruit trees establish through natural regeneration of seeds grow slowly without any nutrition, start bearing fruits after a long period and produce fruits of inferior quality. Hence these species have remained neglected without any commercial importance. As some of these species are tolerant to harsh agro-climatic conditions, they have excellent potential for establishment on marginal and wastelands throughout the tropics. Fortunately during the last 1-2 decades, suitable technologies have also been developed to improve the productivity of these crops. However there is further need to set up field demonstrations to provide first hand exposure to the farmers for popularising these species in the field.

Scope for Production of Ber and Tamarind

Among the underutilised fruit crops, ber and tamarind are extensively used in India. Ber fruit is mostly used for direct consumption. Although ber is not classified as a superior type fruit for consumption at breakfast or other meals, there is good demand, particularly from the children. The blend of a sweet and sour taste makes this a tempting fruit. Tolerance to a wide range of soils and water with high salt concentrations, early maturity and high profitability are some of the salient features of the ber tree. The selection of superior varieties, use of budded plants and control of fruit borer, have improved the economic benefits of this crop and reduced the gestation period. Furthermore, the annual pruning of trees has been helpful to produce fuel-wood and food crops along with the fruits, thereby increasing the income. Ber fruits generally come to the

market during October - December, when other major fruits are not available. Low cost of production, better quality and high nutritional value are other points in favour of this crop. In spite of such advantages, due to low cost of establishment and high net income of Rs. 40,000-50,000/ha, ber is not being cultivated on an extensive scale in India.

Tamarind is another important tree species in India, where the fruits are used regularly as a condiment in traditional cooking. Trees are hardy and tolerant to a wide range of soils and moisture stress. Apart from the fruits, the wood is considered as a premium quality construction timber. In spite of heavy bearing and higher income, tamarind has not been considered as a commercial crop because of long gestation period and non-availability of superior quality planting material. It is only during recent years that a few natural selections have been made from the wide range of germplasm available in the field. Subsequently, suitable vegetative propagation techniques have also been developed to produce plants from desirable mother trees and induce early bearing. With such technical interventions, tamarind cultivation is becoming very attractive on degraded lands. However, field demonstrations and practical training for farmers are necessary to popularise the cultivation of this species.

ROLE OF BAIF IN TREE-BASED FARMING

BAIF Development Research Foundation is a voluntary organisation engaged in conservation of degraded natural resources and introduction of appropriate technologies for ensuring optimum use of these resources to provide sustainable livelihood to the rural poor. Soil and water conservation through watershed development and development of degraded wastelands and marginally productive agricultural lands through tree-based farming are the important components of the development programmes. These programmes also address the issues of environmental protection, improvement in the ecological balance, women empowerment, food security and development of local people's organisations to implement the programme in the long run.

BAIF has demonstrated that a family owning 0.5 to 1.0 ha degraded land can take up tree-based farming, combining various crops and technologies to enhance the land productivity and the income. Under this programme, the poor land owners are encouraged to establish fruit plants as the main crop and fodder, fuel, timber and medicinal plants on field bunds and border. The bund planting helps as a fence-cum-wind break, while generating additional income. The interspace in the main field is used for growing arable crops, generally the food crops, normally cultivated by the local farmers, with improved agricultural practices. Development of the eroded lands into small plots, formation of contour bunds, use of organic manure, green manures and mulch, application of bio-fertilisers, vermiculture and bio-pesticides, selection of improved varieties and certified seeds and making optimum use of the

available water for irrigation would generally result in increased agricultural production to the extent of 50%-200%, in spite of 10-20% of the land being used for establishing tree species. The presence of farmers in their fields almost throughout the year, itself helps to boost their agricultural production and sustain their livelihood, till the fruit trees start bearing.

Presently, the most popular fruit trees cultivated on such degraded lands by the participating families are mango and cashew. The reason for their preference is authentic information available on the economic benefits of these species, easy availability of planting materials, tolerance to water scarcity and assured market for the produce. Among these two species, cashew is preferred over mango, as it is difficult to organise the marketing of mango fruits, grown in remote areas. Cashew requires humid tropical climate and it may not bear fruits on high altitudes and under low humidity. Cultivation of these species has some limitations, particularly in soils of shallow depth, high or low pH and moisture stress. Thus BAIF started exploring the cultivation of less known hardy fruit species on degraded lands. These species include ber, custard apple, tamarind, Indian gooseberry, etc. Among them, tamarind and Indian gooseberry are widely accepted by the farmers because of their hardiness, low cost of cultivation, higher yields, ready market and higher profits. Farmers still have some reservation about ber because of the problem of pests and fear of glut in the market, when cultivated on a large scale. Nevertheless, it was observed that with careful selection of suitable varieties, appropriate technology for establishing plantation by *in-situ* shield budding, proper training and pruning and timely plant protection, ber can become the most attractive fruit crop in certain parts of India, particularly where the ground water is salty. The plantations established on sandy soils, using brackish water were able to yield a bumper crop of Gola variety during the third year and earn about Rs. 50,000/ ha during the fifth year.

SUPPORT FROM ICUC

Based on the technologies developed and varieties selected for increasing the production of ber and tamarind, BAIF has now developed a package of cultivation practices for these crops. However, farmers were hesitant to cultivate these species on a large scale. There is a need to develop a suitable extension strategy to popularise the cultivation of these crops. At this stage, timely support came from the International Centre for Underutilised Crops (ICUC), University of Southampton to strengthen this programme. The aim was to create awareness and impart skills for cultivation of these crops as an economic activity. The key target groups identified were Progressive Farmers and Field Extension Officers from Western India, where these crops are naturally grown and the cultivation can be expanded profitably.

The Extension components identified for promotion of these crops were:

1. Setting up of field demonstrations
2. Development of field manuals covering ideal cultivation practices
3. Organising short term training separately for the Farmers and Field Extension Officers in local languages, namely in Kannada, Marathi and Gujarati
4. Preparation of a poster for each crop, covering necessary information to motivate the farmers and to impart skills for optimising the production
5. Display of posters in prominent locations in rural areas and organisations of campaigns
6. Setting up of nurseries for supplying good quality planting materials
7. Appointment of Extension Officers to provide technical advisory services
8. Development of Farmers' Organisations for organising marketing.

ACTIVITIES INITIATED

The target area selected for promotion of ber and tamarind were Karnataka, Maharashtra and Gujarat, where large stretches of wastelands suitable for the cultivation of these crops are available. Presently BAIF is implementing various development programmes in these states. BAIF has also established research, demonstration and training facilities in these states at its campuses located at Urulikanchan (Maharashtra), Lakkihalli (Karnataka) and Nanodara (Gujarat). At Urulikanchan, BAIF has established a mother orchard of tamarind varieties, collected from various locations and set up a nursery to produce grafted tamarind plants. Tamarind orchards of different varieties, established from grafted plants have also started bearing on this campus. At Lakkihalli campus, different varieties of tamarind trees have started bearing fruits from the fourth year. Looking to the growth of the trees, a large number of farmers are procuring grafted plants from the campus. At Nanodara, a ber orchard of Gola variety has been established for demonstration. Looking to the economic benefits, a large numbers of farmers have taken up the cultivation of ber on their barren lands.

Apart from these plantations, several farmers growing ber and tamarind were identified in these states and the cultivation practices followed by them to boost the production were recorded. These orchards are presently being used for demonstration.

Based on the best practices developed by the farmers and available literature, posters and field manuals were designed by BAIF to create awareness among tree lovers and farmers. The manual is intended to be used as background reading material by the trainees participating in short term courses. It can also

be used for reference by the cultivators. The manuals, initially drafted in English were presented to several Field Extension Officers, seeking their suggestions and hints on cultivation practices provided by experienced farmers and technicians and these were incorporated in the texts. The manuals have now been translated in three regional languages for distribution to the extension officers, field guides and cultivators interested in growing these crops.

The first training course on tamarind and ber cultivation was organised in Marathi and Gujarati for field technicians and farmers, during November-December 2001. While interacting with the extension officers and farmers, it was realised that most of them did not have adequate knowledge about varieties and techniques, helpful for improving the production. Training provided an opportunity to develop a positive attitude to cultivate these crops as an income generation activity in the near future. Extension officers felt confident with promoting the cultivation of these crops, by highlighting the economic advantages of these crops over other food and fruit crops.

During the discussion, the participants felt that there are several constraints for promotion of tamarind and ber on a large scale. From the information collected from the farmers engaged in ber and tamarind cultivation, it was evident that both of the crops have the ability to establish well on wastelands and poor agricultural fields, where water supply is a major constraint. With proper land development, establishment of the orchard with grafted plants and provision of irrigation during critical periods, the returns from these crops can be significantly higher than the income from most of the agricultural crops. Indeed with the establishment of these plants, farmers will be able to use the interspace for cultivating seasonal crops and enhance the agricultural production as well. Finally, these crops can provide green cover on the degraded lands and improve the eco-system. The uniqueness of these species is their ability to protect the environment, while providing sustainable income to the farmers. This is a unique afforestation programme where the owners can earn fabulous income, without cutting the trees. Thus these species deserve priority for promotion under community forestry programme as well.

The constraints for expanding the cultivation of ber and tamarind are:

- non-availability of planting materials
- lack of technical advisory services to provide guidance in the field
- poor infrastructure to organise the marketing of the produce
- high initial cost of establishment on degraded lands, particularly where water is a major constraint
- lack of information about the economic benefits.

CONCLUSION

From the above observations, it is clear that the strategy adopted by ICUC and BAIF to promote these underutilised fruit crops are going in the right direction. With the initial support from ICUC, it was possible to realise the present level of knowledge and understanding about these crops among the local people. The project has now empowered us to focus on specific issues, which are affecting the promotion of these crops. The project has helped us to develop extension kits and training capabilities. In addition to these activities, BAIF will utilise its existing extension network to promote plant nurseries and provide technical advisory services to needy farmers. The project will certainly benefit the rural poor while improving the eco-system in rural India.

UPTAKE OF INFORMATION FOR EDUCATION AND TRAINING

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INTRODUCTION

The five *Annona* species described in the Monograph and Field Manual are very important underutilised crops used as food, folk medicine and as income generation for rural people. ICUC's definition of an underutilised crop is "a cultivated species already domesticated and produced in limited geographic area, but which is amenable to improvement and further agricultural and commercial exploitation". There are major constraints to the effective use of these crops and the access to information on use, production, processing and excellent marketing. To understand a new method or technology it is necessary not only to transfer the technology and information, but it is also necessary that the growers understand what this information means and how it can be used. Although training and information are different aspects of technology transfer, to exclude one from the other is very difficult since they are highly and intrinsically interdependent.

Therefore, the ways through which information can be used on training and education are very important and I will try to describe them in this short paper.

UPTAKE OF INFORMATION

Education

Education is the process through which a country or community can democratically encourage their development away from the poverty and inequality among people. The uptake of information has an important role for this purpose.

The modern educational system impel the society and the government to develop a permanent effort of a synthesis between the experience and aspiration of people, between comfort (well-being) and productivity and, finally, between supply and opportunities to all for quality and continuity of this supply. The understanding of information and technology is very important to High School or University professors in order to facilitate their teaching and to the students or growers to improve their knowledge and ability to be a good professional in the future. Of course, the inverse

situation is also true: rural people would improve their ability and would better uptake of the transferred information, if they were better educated.

A Monograph and Field Manual for Extension Workers are some of the best tools to improve the uptake of information in the education area. However, the information would be better transferred by using a common language between the speaker and the listener. Therefore, the translation of the information and technology described in these materials into local languages should be provided, now that education is an important tool for development and economic transformation of a rural community.

Training

A trained and skilful grower is a person capable of easily understanding and using a certain technology. Our experience, as researchers and annona growers, indicates that there are different ways to facilitate the understanding of a technology or information for training of growers and extension workers. Generally, they need not only explanation of a certain technology orally through talks or seminars, but also written material, such as Field Manual, which must be clear and easy to understand.

The information about annona species should be easily understood and transferred through field days and method demonstration in the field. Several courses and training about annona propagation, especially for extension workers and community leaders, have succeeded when these people have a Monograph to read or when they have a Field Manual to understand the instructions, well prepared illustrations and photos.

Some information can be misunderstood through brevity, which results in an ineffective increase in yield and quality. For example, the information that 5% of the extract of annona leaves is an important insecticide to control mosquitoes is better understood if graphics and figures are shown in teaching material used for the training of growers, such as the Monograph and Field Manual for Extension Workers.

Another important way that growers can learn is through the use of radio and television, since the information inside the Monograph and Field Manual for Extension Workers will be clearly understood and quickly disseminated.

CONCLUSIONS

The potential beneficiaries of the *Annona* Monograph and the Field Manual for Extension Workers are the small fruit growers and their families, which will enhance the ability to grow and to market their exploited crops. By

enhancing the productive capacity of the annona crop, growers will reduce the poverty, improve the nutrition of women and children and generate better income. In addition, with the access and the understanding of information on production, processing and marketing through extension materials, annona growers can overcome some of their problems and then increase their income and promote better standard of living for their families.

BENEFITS OF ICUC PUBLICATIONS FOR RESEARCH WORKERS

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The publications of the International Centre for Underutilised Crops (ICUC) are of considerable benefit to the researchers involved in studies on underutilised crop species in several ways. These publications are comprehensive in all aspects including production systems, postharvest and processing, product diversification and marketing. Furthermore, the available genetic diversity of the species has been fully covered in these publications enabling researchers to embark on tree improvement programmes.

It has become very obvious through these publications that Tamarind (*Tamarindus indica*) and Ber (*Ziziphus mauritiana*) are species with high commercial potential although not fully exploited by any of the growing countries of the world. This has been attributed to a lack of adequate information on agronomic aspects, processing, product diversification and marketing. These books have highlighted many of the important issues in regard to their development and commercialisation. At policy level, it was evident that many of the underutilised species, in spite of their potential, have not entered into the national research agendas. These publications have created wide publicity and awareness among researchers and policy makers that in the future they may enter the research programmes of the national research systems. This aspect has already been dealt with by the Sri Lankan national research system in the prioritised research agenda of Sri Lanka 2002 – 2005. Tamarind has been afforded a significant place for cultivation in the rainfed marginal lands of the dry zone. The studies have also been to collect Tamarind from different areas of the country and to study variation using DNA markers and isozymes. Similarly, many other underutilised species such as Annonas and Garcinia could be exploited when information is collected and published in a readily available form for use by researchers for their improvement and utilisation. For undertaking such an arduous task the ICUC should be commended as the direct benefits will be accrued by small farmers.

While collecting information on various aspects of tamarind, particularly in Asia, it became clear that there has been hardly any effort by scientists to improve tamarind as a crop plant. Although research has been undertaken by individuals in research institutions and universities in the growing countries on an *ad hoc* basis, the information was scattered. Therefore the impact even at the local level has been unimpressive. These books published by the ICUC have all information in a logical sequence that the researchers will

find it easy to identify gaps, in research and development in order to improve these presently underutilised crops.

The genetic resources of these underutilised crops will form the basis for crop improvement. It has become apparent that germplasm is getting lost at a rapid rate due to cutting down of trees without realizing their value. The information presently available indicate that germplasm collections have not been undertaken by many countries and even where attempts have been made the collections do not cover the entire range of the naturally available germplasm. Therefore, a crucial pointer for researchers is that collection and conservation of germplasm will be an essential prerequisite for improvement of tamarind. Based on the diversity of germplasm, tree improvement programmes can be developed. In the case of both Tamarind and Ber, research gaps have been clearly identified in the publications. In Tamarind very little is known about the genetic variation and floral biology. For the benefit of the researchers this publication has pinpointed the need for information on genetic variation, genetic structure and effective size of the breeding population both in natural and naturalised areas. The use of molecular techniques (DNA finger printing, isozyme studies etc.) has been identified as tools to assess the genetic variation among and within populations which could help to formulate management of genetic resources on farms. For the benefit of researchers, these publications also point to the importance of provenance trials, which will enable them to identify their performance, growth and quality characteristics for different locations. Of particular importance is the development of sweet varieties of tamarind which has an emerging global fresh fruit market. The sweet varieties are exported by Thailand at present, but not by any of the other countries. These studies will form the basis for commercialization of these species in the other countries as well, based on the market demand for different products.

These books provide adequate information for researchers on postharvest processing and product diversification of Tamarind and Ber. Tamarind pulp deteriorates under normal storage conditions: this problem needs the attention of food technologists. There is an urgent need to develop technologies for manufacturing tamarind products for better use of the pulp and seeds. This publication is showing impact in that ITDG in UK is keen to obtain further information on the process of developing pectin from tamarind seed kernel powder. This is a low cost alternative to expensive fruit pectin, which could be used by small-scale processors in developing countries.

These books have amply demonstrated the lack of information on various aspects of growth and development, harvesting and processing product diversification and marketing of Tamarind and Ber. Therefore, the researchers have been provided with adequate information and ample opportunities to develop these underutilised crops for the benefit of both growers and processors.

MANAGING INFORMATION FOR KNOWLEDGE SYSTEMS DEVELOPMENT: THE PHILIPPINES NARS EXPERIENCE

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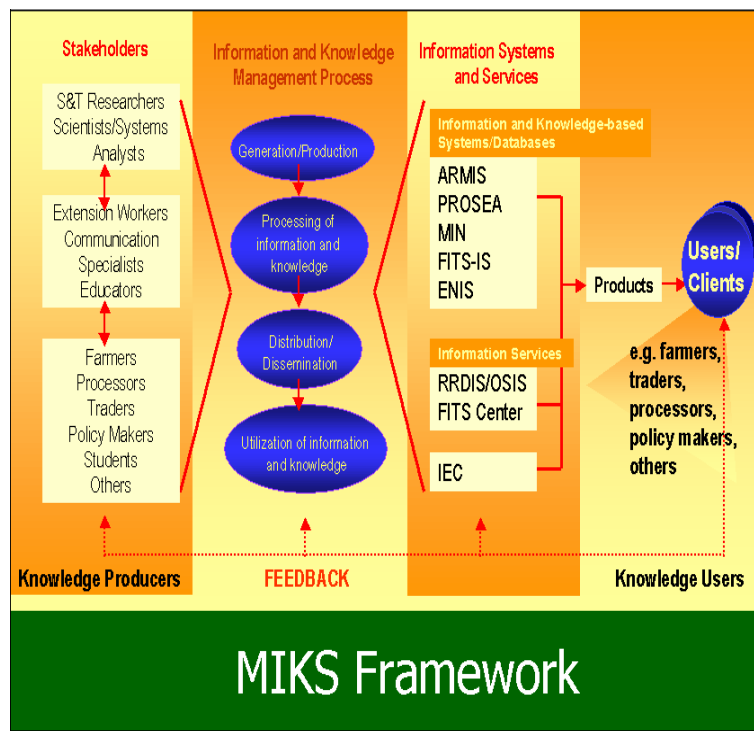
INTRODUCTION

Information is a very vital resource in any organization. The effectiveness of management heavily relies on the availability of accurate, timely and relevant information. In making a decision, the manager explores options based on the information available to him. Hence, information should be well managed, “assembled” or processed into a usable form to be available when needed (Mamon, 1989).

The science and technology (S&T) sector, as the country’s main source of technological/information support faces a great challenge in facilitating the development process in agriculture and natural resources (ANR). The Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) realised as early as 1974 the need to establish a formal information system to support its function as the country’s national sectoral planning council in ANR. Faced with an enormous task of monitoring thousands of research and development (R&D) studies undertaken by more than a hundred R&D agencies/institutions nationwide, PCARRD installed its Management Information System (MIS) to provide information processing support to management as basis for policy formulation and decision-making.

The framework for managing information and knowledge-based systems and services in the Philippine NARS considers both the scientific community and the users’ group as major stakeholders in the information/knowledge generation and utilization continuum (Figure 1). The members of the scientific community (researchers, scientists, and systems analyst) serve as major stakeholders in the generation and processing of information into useful decision-making tools. The extension workers, educators, information/communication specialists and policy advocates, on the other hand, facilitate the distribution and dissemination of information and knowledge through the information/knowledge systems and services. Likewise, policy makers use these information and services in the formulation of policies and decision-making.

Figure 1 MIKS Framework



Packaging of information products or services, however, is based on the users' needs (farmers, processors, traders, policy makers, students, etc.) identified through the information, education and communication (IEC) process. IEC is one of the key feedback mechanisms to match the needs of users with information products/services to be provided.

This paper deals with the nature of the Philippine ANR Research and Development (R&D) System. It also presents PCARRD's major information and knowledge-based systems (MIKS) as decision-making tools for various stakeholders. In particular, this paper highlights the case of the Mango Information Network (MIN) as an effective tool in improving the Philippine mango industry and as a potential model for other underutilised crops in the Asian region.

THE PHILIPPINE AGRICULTURE AND NATURAL RESOURCES (ANR) R&D SYSTEM

Two basic structures comprise the Philippine agriculture and natural resources R&D system: PCARRD, a planning and coordinating body; and the National Agriculture and Resources Research and Development Network (NARRDN), a network of research and development centres/stations.

PCARRD

PCARRD is a planning and coordinating council for agriculture, forestry and natural resources under the Philippines' Department of Science of Technology (DOST). The council is responsible for the formulation of strategies, policies, plans and programs for science and technology development; programming and allocation of government and external funds for R&D; monitoring of R&D projects; and generation of external funds in ANR.

PCARRD has three main organizational components: the Governing Council, the Technical Advisory Committee, and the Secretariat. With this organisational setup, PCARRD involves a whole range of research, education, development-oriented, and policymaking entities concerned with national and regional development. Moreover, it brings together the expertise of policymakers, scientists, educators, extension workers, and entrepreneurs/producers both from government and the private sector to find solutions to the problems of the farmers and other end-users of technology, in particular, and the country, in general.

PCARRD has long recognised the importance of a closely-linked research and extension system responsive to both national and regional/local needs. A close interaction between and among the different sectors involved in agriculture and resources R&D in the Philippines is evident at various levels.

THE NARRDN

Upon the creation of PCARRD in 1972, it was mandated to establish, support, and manage the operation of a national network of research centres and stations in agriculture and natural resources. The NARRDN, which is being coordinated by PCARRD, is composed of R&D centres/stations of line agencies such as the Department of Agriculture (DA), Department of Environment and Natural Resources (DENR), state colleges and universities (SCUs), and private agencies/institutions.

Member-agencies in the NARRDN are classified into:

- 4 national multi-commodity R&D centres
- 7 national single-commodity R&D centres
- 20 regional R&D centres
- 88 cooperating stations
- 9 specialised agencies

Each of these R&D centres has their commodity and area of responsibility based on the agro-ecological/agro-climatic zones. Flagship commodities are identified based on the rainfall patterns, climatic features, distribution of solar energy, land use, soil classification, and other factors that will define the applicability of high impact technologies.

National R&D Centres

The National R&D centres conduct basic, applied and adaptive researches on one or more commodities (see appendix A). These centres have the capability to do research across a broad range of disciplines. In addition, these centres put together packages of appropriate technologies for different commodities and/or dominant production systems after successful verification in the regional R&D centres and cooperating stations located in the different agro-ecological zones/ecosystems of the country.

The national R&D centres are of two kinds, namely: the national multi-commodity R&D centres and the national single-commodity R&D centres.

Regional R&D Centres

A regional centre conducts applied and adaptive research on commodities of major importance in the region where the centre is located. It verifies the technology developed/generated in the national research centre and fine-tunes the packages of mature technologies to suit regional conditions.

These R&D centres are strategically located in places representing basic agroclimates. Most of these centres are based at state colleges and universities (SCUs) while others are under the DA.

Cooperating Stations

Cooperating stations are selected stations of DA and DENR, state colleges and universities, and private research centres or progressive farms located in various parts of the country. They provide facilities and/or sites for adaptive trials or field experiments taking into account microenvironment differences.

Specialised Agencies

These are institutions with responsibility for a specific commodity or commodity mixes under a given sector. Their involvement in the NARRDN is based on the laws and/or decrees that created them. These include private agencies with research facilities specializing on specific commodity. These agencies include the Philippine Carabao Centre (PCC) and the Twin Rivers Research Centre (TRRC).

Overall, the NARRDN is composed of 69 research centres/stations under the DA, 12 stations under the DENR, 40 SCUs, 3 research institutes under the DOST, and 3 private research agencies.

The Regional R&D Consortia

The NARRDN was organised into a regional grouping called R&D Consortium. The Regional R&D Consortia were formally established in 1976. The consortium arrangement, designed to optimise use of limited resources among research centres at the sub-national level, involves a series of satellite institutions around a base agency. Regional leadership resides in institutions or agencies best qualified to operate the consortia considering their existing human resources and facilities. A consortium serves as a mechanism for priority setting, planning, monitoring and evaluation of R&D projects, technology promotion, and sharing of resources of member-agencies at the regional level. Of the 14 consortia, 9 are based in state colleges and universities, 4 in DA regional offices and agencies, and 1 in the DOST regional office.

The consortium secretariat administers, coordinates, and controls the consortium according to the policies and guidelines promulgated by the Regional R&D Coordinating Council (RRDCC) composed of the heads of member-agencies. The Research and Technology Working Group (RTWG) composed of research directors/coordinators of member-agencies, on the other hand, serves as the technical arm of the RRDCC. Logistic and staff support are provided mostly by the base agency in the region.

The secretariat is composed of the Consortium Director, and coordinators for applied communication (Regional Applied Communication Office or RACO), information system management (Regional Management Information Services or RMIS) and technology promotion (Regional Technology Promotion Group or RTPG).

The Philippines NARS banks on the full potential and utilisation of information and communications technology (ICT) in facilitating information and knowledge generation to increase productivity and sustain

the competitiveness and innovative capacity of the agriculture and natural resources sectors. It also capitalises on the government's recognition of the strategic role of ICT in national development with its adoption of the **National Information Technology Plan of the 21st Century** or **IT21** as the overall framework. The plan is actually a vital component of the **Medium-Term Philippine Development Plan (MTPDP) for 1999-2004** as it places ICT development as one of the high priority areas for national development.

In line with the abovementioned policy frameworks and initiatives, a strategic program riding on the ICT wings is being implemented by PCARRD. This is the Agriculture and Natural Resources Information Network or AGRINET (AGRINET – Program Title (1999-2001). For year 2002, change in title is being considered by PCARRD Management.) The AGRINET program consolidates all information and communications technology (ICT)-based projects/activities into a single and bold strategy towards an accessible, stable, consistent and sustainable information and technology delivery system. This said program aims for electronic connectivity of PCARRD, NARRDN and the Regional Consortia to facilitate efficient and effective content build-up and dissemination of S&T-based agriculture and natural resources information and technologies through enhanced web-based network. This aims to promote accessibility of international sites with similar knowledge-based systems. To effectively operationalise the AGRINET Program, PCARRD embarks into four major implementing strategies, namely:

- a) establishment of virtual agrinetwork
- b) information and services delivery system
- c) ICT capability building; and d) networking/linkages.

PCARRD's MAJOR INFORMATION AND KNOWLEDGE-BASED SYSTEMS & SERVICES

Agriculture becomes more complex and sophisticated as it develops over the years, hence, associated problems such as maximum productivity, resource conservation, and use efficiency are best understood and resolved by an appropriate decision-support system that must be knowledge-based. In ANR R&D, the role of managers is as crucial as the role and value of information. With the management's task of decision-making and problem solving, their quality and effectiveness are affected by accuracy, sufficiency, and timeliness of information.

PCARRD, being the central body that directs and monitors ANR R&D activities in the country, has developed and amassed a wealth of information and technologies generated by the NARRDN and recognised that research

information is useless unless communicated to and applied by the intended users. As the hub of R&D information, PCARRD continues to strengthen its information management capability to effectively serve its clients in their various needs and concerns. At the national (PCARRD) and regional (R&D consortia) levels, PCARRD implements various information systems and services that institutionalise data and information gathering, processing, synthesis and integration in support of the implementation of national and regional R&D and technology management programs.

As the globally-acknowledged Philippine National Agricultural Research System (NARS), PCARRD over the years has developed and implemented comprehensive information and knowledge-based systems such as the Agriculture and Resources Management Information System (ARMIS), Plant Resources of Southeast Asia (PROSEA) Databases, El Nino Information System (ENIS), FITS Information System, and most importantly, the Mango Information Network (MIN).

PCARRD has also disseminated nationwide R&D information and knowledge through information service mechanisms like the Regional Research and Development Information Service/One-Stop Information Shop (RRDIS/OSIS) and the Farmers' Information and Technology Services (FITS) Centre.

PCARRD made all these information available on the Internet with URL www.pcarrd.dost.gov.ph, which serves as the agency's window to the world. To maintain Internet connectivity, PCARRD sustained its PLDT leased line subscription with 128 kbps bandwidth enabling hook-up and maintenance of free ISP subscription via APAN-ASTI-DOST's ASEAN Internet Interconnection Initiative (AI3) project. The PCARRD Web site adopts a vision of "*a dynamic, timely and world class web towards a dynamic and sustained knowledge-based system in agriculture, forestry and natural resources research, development and technology management*". Hence, the PCARRD Web site aims to:

- a) provide access to up-to-date data/information over the network to enable information sharing and exchange
- b) set-up discussion group on specific topics in agriculture, forestry and natural resources to be participated upon by intended users/clienteles to build a knowledge-based system
- c) set up a frequently-asked-questions (FAQ) site about the Philippine AFNR
- d) host key organisations/players in AFNR including resource centres and donor agencies.

The Agriculture and Resources Management Information System

ARMIS is an information system supporting R&D management activities and policy initiatives in agriculture, forestry and natural resources (AFNR). The windows-based ARMIS, developed in Oracle, was developed to facilitate research program planning, monitoring, and evaluation of all research projects being coordinated by PCARRD. The government, private sector, or foreign donors either fund these projects. It can provide users with reports such as Detailed Masterlist, National R&D Program by sector, by commodity, etc.

The ARMIS' major sources of data are the members of the NARRDN now composed of 128 research centres involved in the generation and verification of technologies based on their regional commodity responsibilities. The ARMIS is installed in 14 Regional R&D Consortia offices and regional MIS units are trained on its use and maintenance to streamline/strengthen research management operations. Data input and updating is delegated to the Regional MIS staff.

It is envisioned that starting in 2002, the system would be available through the web. Updating and information retrieval will be easier for policy formulation and decision-making and nomadic access to the database can be done by the regional S&T managers, scientists/researchers, and other intended clientele.

Plant Resources of South-East Asia

Consequences of progress and development brought forth neglect and exploitation of the plant resources of South-East Asia. Realising the need to document the 5000 – 8000 plant resources in the region for natural resource management, the international, autonomous, non-profit organisation called the PROSEA Foundation was formed. As an international program, PROSEA focuses on documenting and making available existing wealth of information on the plant resources of South-East Asia for education, extension work, policy-making, research and industry. As one of the six member-countries, the Philippine Country Office is being managed by PCARRD with regional nodes stationed in the 14 regional consortia.

In the pursuit of its goals, PROSEA has developed an information storage and retrieval system called PROSEA Databank which consists of six databases:

BASELIST:	checklist of more than 6200 plant species;
CATALOG:	references to secondary literature;
PREPHASE:	references to literature from South-East Asia;
ORGANYM:	references to literature of institutions and their research activities;
PERSONYM:	references to specialists;
TEXTFILE:	all texts of PROSEA Handbook volumes and additional information; and
PHOTFILE:	images of plant resources of South-East Asia.

The PROSEA Philippine Country Office embarks on three main activities:

- a) databank development and utilization, mainly through the NARRDN
- b) assistance in preparing PROSEA Handbook
- c) production, distribution and dissemination of publications and other relevant outputs.

In 2001, the country office published the *PROSEA Herbal Homepage*, which contains information on medicinal plants and herbal medicine. This website (www.pcarrd.dost.gov.ph/prosea/proseaherbal/index.htm) contains four main sections:

- Species List
- Techno-Catalogue
- Indications Index
- Kitchen Technologies and FAQs

FITS Information System

The development of FITS Information System became the first concrete step in utilising IT to achieve the FITS/Techno Pinoy Program's service-oriented goals. Generally, it aims to serve as a viable tool to facilitate faster access to information to fast track the delivery of services to clients in AFNR. Specifically, it hopes to:

- a) organise data available on technologies whether from local, regional and other sources
- b) provide an up-to-date inventory of agriculture-related publications and video materials that are available in the FITS/Techno Pinoy Centre
- c) make available to FITS clients IT-based services.

The FITS Information System was developed as a Windows-based system and is composed of seven (7) major databases, namely:

- technology
- experts' profile
- farmers' profile
- contact firms
- trade/production statistics
- publication
- technology video materials.

Technology

The *technology* database captures data on AFNR technologies generated by the R&D institutions in the area. These technologies are considered mature and are ready for dissemination to clients within the locality of the FITS centre and nearby communities. Likewise, this database serves as source of technologies that are being subjected to validation and assessment as to their potential for becoming an enterprise. Indigenous or rural people's knowledge is also being considered for documentation but with some provisions for validation by both the knowledge generator and the concerned R&D institutions prior to dissemination.

Experts' Profile

This database provides an inventory of AFNR researchers that can be tapped for technical and consultancy services by the FITS clients in the area. The FITS centre staff refers to this database in such case where a client needs to avail of the expert's services such as pests and diseases management, latest production technologies, etc. The experts' profile is not limited to experts within the locality but also includes researchers/scientists from other regions.

Farmers' Profile

This database contains the farmers' socio-economic profile, which includes personal information, total farm size and characteristics, commodities and other agriculture-related activities, and annual income and its sources. It also documents farmers' information and technology service needs, thereby, serving as a dynamic feedback mechanism to ensure the relevance of service being provided by the FITS Centre.

Contact Firms

This database contains the firms/establishments, which the FITS centre may refer to clients for business partnership. To name a few, these firms include: *processor, dealer, wholesaler, retailer, exporter, importer, equipment manufacturer, fabricator, assembler, repair shop, financing institution, R&D centre, nursery, and chemical outlet.*

Trade/Production Statistics

This database is a collection of numerical data on production and trade of a specific area (province, municipality or a farming community). This includes information on the area's primary commodity (crops, livestock, forestry or fishery sectors) and its corresponding trade and production data. Production data comprise the volume and value of production including the specific unit of measure and price. Trade data, on the other hand, include name and address of buyer, required volume and buying/selling price.

Publication & Video Materials

The *publication* database provides an inventory of publications and other print materials that are available in the FITS Centre. Some materials may be labeled "*for free distribution*" or "*for sale*". This database enables the FITS centre staff to easily locate information materials being requested by its clients. Data elements include the title and author, commodity, language/dialect used, abstract, and frequency of use.

The *video materials* provide an inventory of technology/information materials in video packages. Just like the *publication database*, it also aids the FITS centre staff to quickly retrieve video materials as requested by clients. Key data elements are the tape title and description, commodity; language/dialect used, and time length.

El Nino Information System

In response to expected effects of El Niño, PCARRD has been tasked to lead S&T intervention activities. PCARRD set into motion the implementation of research and development on mitigating the effects of the phenomenon with fund support of ₱10M from the Department of Agriculture (DA). One of the priority projects under the programme is the establishment of an information system on the El Niño phenomenon.

As planned, the project was able to establish a web-enabled database focusing on El Niño-related information. Programme outputs included IEC materials on the El Niño Southern Oscillation (ENSO), impact assessment

researches, and results of technology development and technology demonstration projects. Also featured in the database are directories of relevant agencies, vulnerability and weather maps, publications and articles about El Niño, links to other sites, and other relevant materials.

The information system also contains a special publication on mitigating the ill effects of El Niño and La Niña in the sectors of agriculture, fisheries, forestry and natural resources. This segment integrates all available information and results of conducted studies into a comprehensive publication. It shall include situationers, suggested mitigating measures and results of R&D activities in the Philippines to provide an exhaustive reference material for local farmers, fisherfolks and extension agents. Such an output would contribute greatly to the government's efforts toward preparing for the succeeding episodes of the phenomenon.

The website [www.pcarrd.dost.gov.ph/enso old](http://www.pcarrd.dost.gov.ph/enso_old), which is the main medium for the system, provides consistent and stable information storage and delivery tool that serve information on the ENSO phenomenon in relation to the sectors of agriculture, fisheries, forestry and natural resources. Its target audiences are the general public, researchers and scientists, extension workers, students and media people. The site boasts of a consistent look, easy navigation, dynamic pages and optimised graphics. The project also aims to come up with a CD-ROM publication of the contents of the information system.

Information Services

Farmers' Information and Technology Service (FITS) Centre. The Farmers' Information and Technology Services (FITS), popularly known as *Techno Pinoy* is an information and technology service centre which provides easy access to services to users of agricultural research in the country, the farmers and agricultural entrepreneurs. It aims to contribute to the empowerment of its intended clients, the lowland and upland farmers, processors, entrepreneurs and traders through the efficient and effective provision of information and technology services. Consequently, it will facilitate the clients' decision-making towards improved production, processing, trading, and marketing. Generally, the centre is managed by the local government units (LGUs).

Techno Pinoy is likewise a resource centre supported by a pool of experts to provide information and technology services in AFNR. A dynamic feedback mechanism, *Techno Pinoy* in partnership with other service providers, packages and provides information and technology services appropriate to the needs and characteristics of its clients. It also immediately relays the clients' feedback on the services to the concerned providers.

Techno Pinoy intends to link various organizations, networks and technology services to build from existing resources a centre near the clients for the sole purpose of making information and technology services accessible and user-friendly. As a natural course of things, it shall involve a large and varied group of people from different sectors who are key players in Philippine AFNR. Such are the extension workers and the local government units (LGUs), the regional Departments of Agriculture, Environment and Natural Resources and Agrarian Reform, the Department of Science and Technology, the Department of Trade and Industry, the Agricultural Colleges and Universities (ACUs), and the research and development institutions.

Regional R&D Information Service. The Regional R&D Information Service (RRDIS) is a strategy to institutionalise regional data and information gathering, processing, synthesis and integration in support of the implementation of the Regional Integrated R&D Program (IRDP). It is responsive to the need for an effective utilisation of information in decision-making in AFNR. Initially, information provided focus on the priority flagship commodity(ies) of the various consortia. Ultimately, RRDIS shall be able to support the compendium of data and information needs on most of the commodities where the region has comparative advantage and on strategic commodities for agricultural self-sufficiency. RRDIS is envisioned to hasten technology transfer and improve the overall management of regional R&D programs by making available timely, relevant and organised body of information to different user groups at one office in the regional consortium and initiate formulation of appropriate and timely policies.

The RRDIS concept was piloted in three consortia in 1995. At present, there are 13 consortia that have institutionalised the concept as a major strategy in regional information management. As a one-stop information shop (OSIS), services provided include, among others, technical services, databases, production of materials for technology transfer, and product demonstrations and samples. The OSIS is anchored on the integration of a consortium's Regional Technical Working Group (RTWG), Regional Applied Communication Office (RACO) and the Regional Management Information System (RMIS) Group in providing timely as well as relevant data and information to users. RMIS and RACO synchronise their respective activities in terms of information processing, and retrieval and dissemination to target users, while the RTWG avails of its technical activities requiring more specialised services (i.e., technical consultancy).

THE CASE OF PCARRD'S MANGO INFORMATION NETWORK

The Philippines is one of the top ten mango-producing countries of the world.

While there were technologies and market information available on mango prior to 1997, these technologies and information were not packaged and disseminated in ways that are easily accessible to mango stakeholders. Thus, in 1997, PCARRD implemented the Mango Information Network (MIN), under the auspices of the United Nations Development Programme (UNDP) and the Department of Science and Technology's (DOST) Gain Export (GAINEX) Programme.

MIN as an information service geared to facilitate the formation of alliances among mango stakeholders is now operational. It maintains a website: <http://min.pcarrd.dost.gov.ph> or the new website <http://202.90.131.19/newmin> with seven major information services, namely: Market, Technology, Pest Clinic, Directory, Policy, Bazaar, and Search and Retrieval. MIN has additional features such as Industry Gatherings, R&D, Publications, Featured Stakeholder, Mango Recipes, Mango Industry, and Trivia. Aside from the web format, MIN has produced information in print and video formats. To access MIN information services, users may visit, call, fax, or e-mail the nodes located in selected provinces.

MIN is housed at PCARRD, which serves as the central processing centre. It has three satellite nodes or extension offices in Zambales in northern Philippines, Iloilo in central Philippines, and Davao in southern Philippines, and one collaborating unit for pest management at the University of the Philippines Los Baños (UPLB), northern Philippines. MIN operates through the collaborative efforts of the satellite nodes connected to the central node via the internet.

What are the developments in the industry triggered by MIN?

- Through MIN's initiative, mango organisations and cooperatives such as the General Santos City Sarangani Fruit Cooperative (GENSAFCO), Visayas Chamber of Mango Industry Inc., (VCMII), and AANI Mango Industry Network (AMIN) Foundation have invested on their own Internet Service Providers (ISPs) to access the MIN website, avail of its services, and request information through e-mail, and in the process, have been introduced to the use of the Internet and its perks. Now that they have Internet access, they have also expressed their willingness to become MIN Access Points (MAPs), where people without Internet could come and ask for assistance in accessing the MIN website.
- MIN's network of stakeholders have expanded through the years, as most of the queries through walk-in visits, calls, fax, and especially e-mail, have been made by children of mango stakeholders. This is because the children are more techno-savvy and open-minded towards new technology than their parents. Thus, they have also

become aware of MIN, referring it to other stakeholders who may need mango information.

- A number of entities involved in the mango industry have advertised in the Internet through the MIN Bazaar Information Services, a virtual meeting place where people can exchange information and post messages or ads. A mango growers' cooperative, GENSAFCO, acknowledged that it was able to reach buyers through the bazaar.
- The Pest Clinic Information Services enables mango growers with pest problems to receive assistance and advice from experts from a collaborating unit without traveling and bringing samples of affected plant parts. Clients from faraway provinces tap the assistance of staff stationed at the MIN satellite node nearest to them. MIN satellite node staff then sends clients' queries including scanned images of the affected plant parts via e-mail to the central node (PCARRD). MIN central node forwards the clients' queries to the expert and then sends the expert's diagnosis and recommendations to the MIN satellite node via e-mail. The system is now called "distance diagnostics".
- Through the Policy Information Services, mango growers, traders, and exporters can readily access important government policies and regulations relevant to the mango industry without going through the maze of bureaucracy. The service contains summaries of policies such as quarantine rules and accreditation of nurseries from the Department of Agriculture-Bureau of Plant Industry (DA-BPI); national standards on fresh fruits and processed mangoes from the Department of Trade and Industry; and setting-up variable grace period for long gestating projects from the Central Bank of the Philippines.

MIN is now at a stage where the "first wave users" are trying the system. An external review team commissioned by DOST to evaluate the GAINEX Program of which MIN is a component noted that there is an increasing trend in the number of users of MIN though it still needs more push to affect mainstream users. The same evaluation team recognised, "the foundation that MIN has set" and upon which future developments can build.

CONCLUSION

This paper stresses the importance of access to information and the capacity to organise information into useful knowledge for different end-users and stakeholders of agriculture and natural resources. The need to develop and implement agricultural information/knowledge systems has been clearly emphasised as a way of responding to such considerations and as an important tool for strengthening the NARS to improve efficiency and

relevance of agricultural and natural resource R&D, achieve food security, alleviate poverty and ensure sustainable development.

The framework as presented in this paper gives recognition to the exercise of synergy among scientific community and user groups in the information and knowledge generation/utilisation continuum. The Philippines NARS also recommends the harnessing of the full potential of information and communications technology (ICT) in facilitating information and knowledge generation to increase productivity and sustain the competitiveness and innovative capacity of the ANR sectors. Likewise, the guidance of nationally-driven policy frameworks is necessary to ensure the availability of crucial support systems such as social and physical infrastructure, training support, etc.

In particular, the PCARRD-MIN can be used as a model for other underutilised crops such as jackfruit, mangosteen, and pummelo. This is to fully utilise these crops and, thus, improve the socio-economic development and nutrition of the people in the Asian region while conserving these important plant genetic resources. Current information holdings of the International Centre for Underutilised Crops (ICUC) and the Underutilised Tropical Fruits in Asia Network (UTFANET) such as newsletters, bibliographies, books and proceedings and ICUC-developed databases on fruits can be important inputs in coming up with appropriate models.

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BETTER INFORMATION FOR BETTER MICROENTERPRISES

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WHAT INFORMATION?

There are many types of information that apply to fruit and fruit processing. They can be put into three categories:

- Information to help choose a product
- Information to help produce and process a product
- Information to help market a product

Fruits, of course, can be produced and processed for home consumption but I am assuming here that we are most interested in eventually marketing the products and that the products will be produced by families or communities, so I am discussing this from the standpoint of microenterprises.

HOW TO CHOOSE A PRODUCT

The Kalahan Educational Foundation (KEF), that I represent, deals primarily with forest dwellers. Forest people invariably have access to many potential resources. Their problem is to identify which of the many plants, minerals and animals near them might become actual resources, that is, which ones could be marketed or used as raw materials for the production of a marketable product.

We are helping various rural communities in their development programmes and we usually spend time with each concerned group to prepare a list of everything available that they think might be usable. Then we review the list to identify those potential resources that they can utilise sustainably. When they eliminate those that could not be used sustainably the list has invariably been reduced to a third or even less.

The next step is to do a preliminary market survey of the remaining items on their list. If there is no market for a product, why bother with it. This requires information but it is not the kind of information that can be mass produced. It is often site specific and usually requires a dialogue with people in the business sector.

While doing this, it is convenient to ask the same resource people to suggest other products that are saleable. That will add a few more items to the list

but then it is necessary to get more information from foresters and agriculturalists. Can the climate and soil produce the products that the business sector is suggesting? This information, again, is not the kind of information that can easily be published. It is usually site specific, both for the market and for the producing community.

In our case a casual conversation with a business man opened up a new opportunity for us. He needed large quantities of achuete (*Bixa orellana*) for flavouring and colouring food products. We have that plant in our forest so we knew we could produce it sustainably. He provided seed for the highest quality product and we produced it. We sold to him exclusively for several years until we felt we had fulfilled our obligation for the original seed. Now we are selling to another business that offers a better price.

I, for one, am also very wary of the representatives of big businesses who travel through the rural areas encouraging people to produce large amounts of specific products. Are they willing to enter a contract so that the market is assured? What price are they willing to offer? They usually refuse to respond to those questions but those are critical points to be considered. Two big businesses recently pushed us to produce coffee but refused to answer specific questions. Their real intention was to increase production of the raw beans so that the price would go down and they could choose the best quality for a lower price. The business would win but many of the producers, after investing time, labour and land, would be left empty handed.

Another problem that must be solved is the need for technical capability to do the processing. One community I have worked with had a large deposit of limestone that could be used for various purposes but the cost of extracting and processing it was too great and the extraction would damage the agricultural land. The project was aborted.

Our own community has soil and climate suitable for the production of mulberries and production of silk. There is not a very large market in our area, however, for cocoons. We have many skilled weavers but they refuse to weave such fine threads.

Some information is needed to help communities to decide on which products they can produce and process, but that information must be connected with access to a potential market.

HOW TO PRODUCE A PRODUCT

Once the potential product has been chosen it is important to produce it properly. Even fresh fruit must be properly picked and handled to maintain its quality while it is on the way to the market. In the case of achuete, the

merchant provided the information we needed for drying it. This is often possible.

When we began producing jellies and jams, however, we did not yet have contact with any market. Twice we had problems with crystals developing on our products after three months on the shelf. We went to the Food Technology Department of the University of the Philippines in Los Banos and asked the teachers there what to do. They cheerfully provided the information we needed and when they saw that we used the information for the benefit of the poor, they continued to help us without charge whenever we had problems.

We continue to expand our utilisation of various wild fruit, all of them underutilised but we have had to develop our own sources of information through our own research, because no one else has handled most of these fruits before. That will be described in more detail tomorrow.

At the present time we are preparing to market mineral water from our mountain springs. We talked to people in the marketing sector and found that the market is quite large. Then we talked to the professors at the university and they gave us the basic information we needed to ensure that the water would not be contaminated in any way. Now we are getting more information from the people who sell ozone generators and filters. We know that we will need to buy the ozone generators but we are still deciding whether we should buy the filters or manufacture our own.

To make these kinds of decisions we need information but, again, this is not the kind of information that can be mass produced. It is best obtained from people who know and are willing to share their knowledge.

When we began processing wild fruits, we first made products according to our own limited knowledge. As the problems with our products developed we studied to develop the basic skills and then did our own research to develop the final recipes. We have spent a lot of time at this but it has been worth the effort. At the present time our greatest resource is our recipes and we protect them well.

The ICUC publications that I have seen today are aimed at this type of information and it is very valuable although there is still a need for the personal contacts that will apply the information to specific situations. It is also necessary to have experts available to answer questions that cannot be handled in publications. We, for instance, made an excellent jelly using tamarind but after only 3 months it develops crystals which are not sugar. We have not yet been able to identify them so we have not yet found a solution. We have been forced to temporarily stop production.

HOW TO SELL A PRODUCT

The most difficult problem to solve for the establishment of any microenterprise aimed at reducing poverty or helping the economy of a community is the problem of marketing.

Even in the first step mentioned above, it is necessary to choose a product that is marketable. Again, in the second step, the product must be processed to meet the expectations of the customers. If it does not meet their expectations, they will not buy it. If no one buys it, it is a waste of time and money to produce it.

We, for instance, discovered an excellent wild fruit known locally as *Biho-lak*. We use it to make an excellent jelly but no one could pronounce the name so they did not buy it. We invented a new name, *Dikay*, which is much easier to pronounce but even then, it was still an unknown product and very few people were willing to part with their money to buy something they did not know.

We discovered that the Ikalahan people, as a general rule, are too shy to be good salespersons in the city, so we established a new company to market our products and the products of other mountain communities. That has made a big difference, but there is still a need to promote such underutilised products so that they become saleable. The education of the market is very critical.

SUMMARY

Information is critical at every step of the microenterprise ladder.

We need information about the environment to be sure that we maintain the biodiversity and that the products that we use can be produced sustainably.

We need information about the potential market before a decision is made to produce or process any product.

We need information concerning the cultural requirements of the various fruits, of course, and technical information concerning possible methods of processing. The processing however is usually determined by the requirements of the market so we need information about the proposed market.

It is not enough, however, to provide information to the prospective producer. Information concerning the product must also be made available to the prospective market. This is the weakest link in the chain. This is the link

that will make or break the plan to utilise these underutilised fruits. Somehow we must educate the market to make more use of them. It is not usually difficult to educate the producers to produce if they are assured of a profitable market.

I must confess my ignorance concerning how to do it. I am a production person. What little I know about marketing, I have been forced to learn because of the very real problem of marketing our own products. It must not be assumed, however, that when you have a good product, people will immediately start buying it. Every product must be marketed and marketing also requires information.

Perhaps together we can find solutions.

Table 1 Processing methods and products

Process	Fruit	Scientific name
Osmotic Dehydration	Guayabano	<i>Annona muricata</i>
	Mango	<i>Mangifera indica</i>
Puree	Guayabano	
	Annonas	<i>Annona reticulata</i>
	Atis	<i>Annona squamosa</i>
	Durian	
Sun dried (after soaking)	Jackfruit	<i>Artocarpus heterophyllus</i>
Sun dried (with/without soaking)	Balimbing	<i>Averrhoa carambelas</i>
Jam	Mangosteen	
	Figs	<i>Ficus sp.</i>
	Guava	<i>Psidium guajava</i>
Packed in sugar syrup	Jackfruit	
	Figs	
	Red Pomelo	<i>Citrus maxima</i>
Juice (flash pasturise)	Lime	<i>Citrus latifolia</i>
Candied rind	Pummelo	<i>Citrus grandis</i>
	Citron	<i>Citrus medica</i>
Fruit Candy	Durian	
	Guava	
	Figs	
Ice Cream	Guaybano	
	Mango	
	Annonas	
	Atis	

USE OF INFORMATION FOR PROMOTION OF UNDERUTILISED FRUIT TREES

**Ms. Shaheda Azami,
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INTRODUCTION

Homestead farming in Bangladesh is subsistence-oriented, with low inputs and productivity. Many indigenous fruits and vegetables currently grown on homestead farms provide food, nutrition, and some income for rural people. However, sustainable increases in production of fruit from homestead farms are essential. Fruit trees suitable for homestead farms include jackfruit, guava, mango, lichi, and banana. At present, these trees are not used very efficiently because of lack of good quality planting material, poor management, and constraints on product development and marketing. Moreover, farmers lack access to the information they need to improve the situation.

Because fruit trees are a source of income for marginalised farmers, quality-planting materials, efficient processing of food products, training, extension facilities, and development support is needed to improve their livelihoods. Limited capacity to market fresh produce, and the loss in quality during storage and transportation to final markets, are major problems for homestead farmers. Farmers often need to wait for traders before harvesting, which presents particular problems during peak production periods and results in losses throughout the market chain.

In the past, there was limited development or transfer of new technologies and strategies to improve and integrate production, postharvest handling, and marketing systems to meet the demand of expanding markets. Development activities must be based on a systematic, integrated approach to supply quality planting materials, supplementing nutrition, and expanding income generation by developing products and markets.

OPPORTUNITIES AND CONSTRAINTS FOR PROMOTING UNDERUTILISED FRUIT TREES

Opportunities

A large and varied number of tropical fruits grow in Bangladesh. Fruits are

important for small holders and provide important nutritional supplements, which improve the quality of diets. Local fruits grown by small holders or collected from the wild often provide additional income. Fruit trees also have positive environmental benefits.

Small food producers could process fruits such as banana, jackfruit, and guava for income generation and employment. In rural areas of the country food processing is a major source of employment. Not only is it already important to the national micro economy, it is also one of the fastest growing sectors in Bangladesh, at 32% per annum. The sector is important socially as well as economically because it is particularly suited to small-scale production by marginalised and vulnerable women. Evidence indicates that when women have a say in the decision making process, they are more likely to spend extra income on education, nutrition, and health; also, as a result of their increased earning capacity, women command increased respect from their families and community members.

However, the technical skills of these marginalised small producers, both men and women, need to be developed and strengthened. These skills include production capabilities (the skills and knowledge needed for the operation of a technology) as well as investment capabilities (the skills and information needed to identify, locate, and purchase suitable technologies). The particular challenge is to identify ways to develop these innovation skills.

In recent years, an emphasis in Bangladesh has been given to crop diversification. Because income from fruits is higher than that from field crops, fruit trees could play an important role in this effort to improve the local rural economy.

Constraints

Despite numerous opportunities created by agro-processing, small-scale holders and processors face a number of constraints, including low yields because of poor planting materials, non-availability of recommended propagation and production packages, and postharvest and transport losses.

Moreover, many underutilised fruits are becoming scarce due to erosion and because they are not exploited commercially. Local market structure is also poor due to lack of proper support from stakeholders. There is also significant wastage during certain seasons.

There are other constraints as well. Access to information about technologies is a major constraint to small-scale production. Small-scale manufacturers are not aware of technologies that may be appropriate to their needs, despite

the fact that they are being widely used elsewhere. This lack of information precludes spontaneous dissemination. Small holders interested in using fruit trees as a source of income generation need to:

- know about availability of genetic resources, propagation, and production methods
- understand the socio-economic aspects of growing and marketing fruit
- have access to and be able to use postharvest and processing technologies.

The particular challenge here is to deliver such information in a manner that can be effective in a country like Bangladesh, which suffers from high levels of illiteracy.

Another constraint faced by small-scale producers is the current unfavourable policy environment. On one hand, the larger, formal agro-processing sector may receive government support in the form of subsidies, foreign exchange allowances, price stabilisation or guarantees, and access to specialists and consultants. On the other hand, the small-scale informal sector has no political influence, despite its combined voting power, and is therefore subject to the vagaries of the national, and often international, economic climate. Thus, small-scale processors and farmers often face unfair competition.

Lack of access to credit is one of the constraints most commonly cited. The majority of small scale holders and processors, especially women, face a variety of problems when seeking credit, including lack of information, high interest rates, lack of collateral, bureaucratic difficulties and misunderstandings, prejudice against women and small scale farmers and processors, and lack of government support in accessing credit.

USE OF INFORMATION FOR PROMOTING UNDERUTILISED FRUIT TREES

A number of national organisations, including government institutions, are involved in fruit tree development, technology transfer, and agro-processing and could play an important role in producing publications and materials for disseminating the necessary information efficiently and widely. All of these publications and materials should be easy to read and understand.

Establishing a technical inquiry service within governmental and non-governmental organisations working in the agro-processing field could create opportunities for access to information.

In this computer age, Internet and web pages play vital roles in disseminating information widely at very low cost to providers and users alike. The Internet allows for the rapid exchange of technical information, making technology transfer simpler and ensuring that new ideas and experiences become available quickly. Using this technology, large, small, and micro level stakeholders working in the agribusiness sector can create a national and international information flow.

Workshops and seminars organised by research organisations and other institutions involved in agro-processing could provide opportunities for researchers, academics, and extension workers to meet, discuss, and share updated information. Socio-economic studies and research conducted by different stakeholders are another source of updated information. Case studies of success stories using underutilised fruit trees or fruits in newsletters can inspire other people to become involved in the business. Information sharing among established national and international networks within Bangladesh and abroad can play a vital role in promoting the importance of underutilised fruit trees. The objectives might be:

- promotion of the use of diverse homestead farm fruit trees
- improvement of the propagation, production & management practices of tropical fruits
- improvement of the nutrition of rural households through fruit tree production

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SECTION 3

CONSULTATION MEETING ON PROCESSING AND MARKETING OF UNDERUTILISED TROPICAL FRUIT TREES

BRIEF CONTEXT AND RATIONALE FOR PLANT DOMESTICATION RESEARCH

Dr. Pornchai Preechapanya, ICRAF, Thailand

ASB-Thailand research in Mae Chaem during the last few years has helped identify and improve understanding of mountain watershed areas where local ethnic minority communities have transformed their rotational shifting cultivation systems to permanent fields, with a resulting substantial increase in the local area under permanent forest. Findings indicate that other results of this change have included the need for use of purchased fertiliser and herbicides in upland rice fields, and an associated substantial reduction in net returns to labour in subsistence rice production. In order to help obtain the cash needed to operate this system, crops such as upland soybeans or maize are also produced on fixed fields using chemical inputs, but returns are modest and costs of chemical inputs are rising. High value vegetable production helps generate cash income in some areas, but many do not have suitable sites or support systems needed for this option. Off-farm employment was another source of cash, but this option has suffered heavily in the wake of the Asian economic crisis.

In other areas of Mae Chaem, various combinations of government forest policies and population growth have resulted in local rotational shifting cultivation systems that use forest fallow cycles that have been shortened to 4-5 years from their more traditional forms of 10 or more years. In many of these cases, some of the former forest fallow land areas have been returned to permanent forest cover. While these systems appear to still be ecologically sustainable without agricultural chemical inputs, upland rice yields are often significantly lower than in areas with longer forest fallow cycles.

Thus, many communities in both of these types of situations now have quite marginal and vulnerable local economies. Projects have been trying to encourage smallholder tree crops (with fruit or other non-timber products), and as many of these communities have extensive local knowledge about a wide range of non-timber forest products, attention is increasingly being turned to how expanded local permanent forest areas can help improve local livelihoods.

Parts of the expanded areas of permanent forest are (still unofficially) allocated for two types of community forest management. The difference between the two is that timber can be harvested from one type ('utilisation' forest), but only with permission from a community management committee, and only for subsistence (not commercial) purposes. In the other type (conservation forest) timber harvest is not allowed. The range of stakeholders have a relatively open

mind, however, about non-timber forest products from both types of forest - especially if production can be managed in a sustainable manner.

Thus, the approach for domestication activities that we are developing here seeks to focus on examples within three initial categories of products:

1. *Commercially-traded products that are currently derived from open access natural forest lands.*

Initial focus here is on improved understanding of product markets, why production still focuses on open access forest, and the potential and constraints for domesticating production into community-managed forest and/or smallholder farm lands.

2. *Subsistence products unsystematically harvested from community forest lands that can also be commercially traded.*

Initial focus is on improved understanding of product markets, management approaches and technologies for systematic sustainable commercial production, and local organisational, institutional and policy conditions needed to support more intensive domestication in community forest and/or smallholder field components of landscape mosaic agroforestry systems.

3. *Commercially traded tree products already grown in smallholder agroforestry systems in some specific areas.*

Initial focus is on improved understanding of product markets, management approaches and practices, and conditions and constraints important for evaluating the potential for further tree crop improvement and/or expansion to other areas.

In order to begin addressing these issues, we propose an initial set of exploratory research activities that will proceed from two directions.

Regional Stage of Domestication Approach

First, we are identifying known products in each of the above three categories that are widely traded in at least northern Thailand. For each of these species, we will explore major production areas in the north, market channels and relevant domestication issues. Explorations will begin with review of data and information from secondary sources, which will then be supplemented with rapid appraisal and assessment techniques at selected field sites.

The preliminary list of products include:

Open-access forest products

- i. young leaves of *Ficus virens* [pak luet]
- ii. fruits of *Arenga pinnata* [luke chit]
- iii. resin of *Gluta usitata*. [rakyai]

Unmanaged community forest products

- i. edible bamboo worm (*Omphisa quscidentalis*) [rote duan]

Smallholder agroforestry products

- i. fruit pods of *Zanthoxylum limonella* [ma kaen] (known seed germination problem)
- ii. leaves of *Camellia sinensis* planted into natural forest [miang]
- iii. fruit of *Durio zibethinus* grown in mixed agroforest [durian]

Local Area Development Approach

Secondly, we plan to conduct participatory surveys in villages in Mae Chaem to assess farmer views on local products in these categories with the greatest potential for further domestication into commercial production systems under either community forest or smallholder farm conditions. Findings will be entered into our GIS system to assist in assessment of their potential for broader relevance in Mae Chaem, and for use in collaborative selection of priority species for further research and development efforts by ICRAF and ASB-Thailand research partners in Mae Chaem.

As a result of this dual approach, we anticipate that:

- Findings from the regional approach should help clarify issues associated with the potential for production of such products under conditions found in the Mae Chaem benchmark research site and other areas of northern Thailand, as well as constraints on further domestication of products harvested from open access and unmanaged forest resources.
- Findings from the local area approach can help identify local knowledge of issues and production potential, constraints or bottlenecks in the domestication process, and characteristics associated with the spatial distribution of high potential sites.
- Findings from both approaches should help identify issues, constraints and opportunities associated with broader policy,

- economic and ecological environments.
- Comparison of findings from the two approaches should help in further development of strategic research, training and development activities to provide constructive and meaningful support for domestication processes.

The outputs of these exploratory research activities will be used to further refine our approach and framework for domestication research in these types of upper tributary watershed conditions, and specify strategic activities for further research and development in Mae Chaem and northern Thailand.

WHAT TROPICAL FRUIT WILL GROW WHERE - A METHODOLOGY FOR MATCHING PERENNIAL FRUITS TO AGRO ECOLOGICAL ZONES, AND DEVELOPING A LIST OF POTENTIAL FRUITS

Dr. Keith Chapman, FAO-RAP, Thailand

ABSTRACT

In the plant kingdom, there are thousands of fruit and nut species of tropical origin that may be considered for Commercial Development. However, there is a much smaller number that actually succeed commercially. This paper presents broad criteria that may be utilised in screening these fruits for Commercial Development.

As a second step, the paper shows how to develop specific criteria for determining Commercial Success in a given region or Agro-ecological Zone.

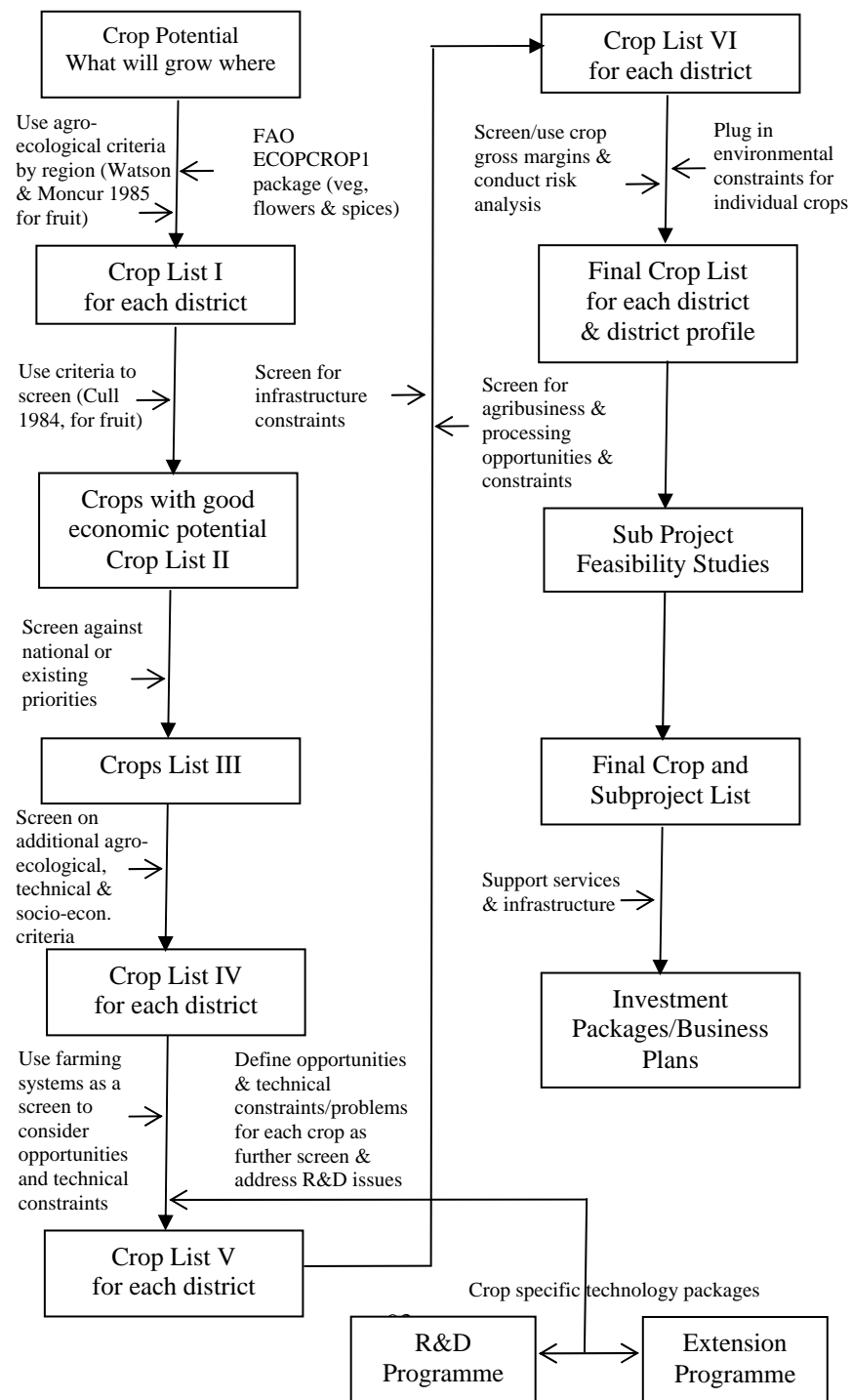
Finally, Liebig's Law of the Minimum is discussed in relation to the criteria, along with development opportunities, potential problems / constraints and specific key extension points, required for success.

Developing new fruits in new regions is a two step process which involves:

- developing a Potential List of Fruits that will grow in a given region or Agro-ecological Zone (AEZ) (matching fruits to AEZ's or regions).
- selecting fruits with Commercial Value (Economic Potential) from the Potential List, for Commercially Successful development in a given region.

The Methodology described in this paper is continually evolving and being improved. However, parts of the Methodology will remain imperfect since questions of value, (value judgments), are involved in the decision making process.

Figure 1 Decision Tree for Defining Horticulture and Spice Crops for Successful Commercial Development



COMMUNITY INVOLVEMENT IN FOOD PROCESSING: THE IKALAHAN EXPERIENCE

Rev. Delbert Rice, Kalahan Educational Foundation, Philippines

The Ikalahan people are a tribal minority people who live in the Caraballo Mountains north of Manila, Philippines. In 1973, when these programs began, very few Ikalahan had even tried to attend a Secondary School and many had never even attended an elementary school. They nearly lost their Ancestral Domain in 1969, however, to highly educated politicians and that motivated them to protect themselves from other such attempts. They were even afraid of some of their own people who had gone out to obtain some education in lowland schools.

The people had good reason to fear formal education. The few individuals who had obtained a little formal education in government schools in the lowlands frequently lost their ethics and either became incapable of earning a living in the mountains or adapted themselves to the lowlands and stayed there. Their education was of no use to their relatives in the mountains. Even worse, some of them utilised their formal education to exploit their friends and neighbours who remained in the mountains.

In 1972, the Ikalahan began a program to solve both problems by incorporating themselves as the Kalahan Educational Foundation. With that legal personality they established their own High School, the Kalahan Academy, so that they could supervise the education of their own youth. They received government recognition for their school in 1974. In that same year they completed the negotiations for a Memorandum of Agreement (MOA No. 1) with the Philippine Government that enabled them to control nearly 15,000 hectares of their Ancestral Domain. Those two documents, however, were only the first tiny step toward accomplishing their goals. There was still much work to be done.

Most of the Ancestral Domain of the Ikalahan consists of steep mountain slopes. At that time many of the slopes were barren but there were also many primary forests. The MOA gave the people sole and exclusive rights to occupy, use, develop and benefit from their Domain but they were required to protect the watershed. Protecting a watershed had never been a need for them. They had too much water most of the time and the problem was how to get rid of it without losing the land to erosion. When watershed protection was included in the MOA, however, it became an important necessity. They knew that to protect their land rights they would have to protect the remaining forests and, if possible, expand them to improve the watershed functions.

The Ikalahan knew that if they expanded their agriculture it would destroy the forests and that would damage the watershed. They also knew that if they expanded their pastures to increase their livestock it would have the same effect. If the watershed were damaged the government might rescind the MOA and they would be driven away from their lands. Somehow they needed to improve their income while still improving the forests. How could they do it?

After much trial and error they finally realised that they could harvest forest fruits and process them into high quality jams and jellies. If people obtained their cash income from the fruits they would not want to cut down the trees nor would they need to expand their pastures or their agriculture. Fruits are a renewable resource because the trees bear fruit every year. The Ikalahan opened a small Food Processing Centre to be managed by the people themselves with the help of a technically capable volunteer.

There are two basic types of food processing. A housewife, or husband, may decide to process fruits or vegetables while they are abundant and store them for a later period of time when food is more difficult to obtain. During my childhood this was the standard in every household and my parents and I spent every spare hour during the three or four months of the harvest and hunting season preserving food for the winter months. We were not concerned about standards because we were the only customers. This activity was critical to our survival. If we did not preserve, we would not eat during the cold months. Such home preservation is much less common in Asia because fresh food supplies are usually available at all times. Certain types of food are seasonal and some food processing is done on the home level but it is not a critical activity for Asian people.

The other type of processing is for the commercial market. When a person or a community desires to process and market food products, there are several important considerations. First, the products must be salable. There is no reason to process anything if there is no demand for it. To stay in business the products must be of a good and standard quality so that the customer knows what he/she is buying. There is no short cut to this. It must be a commitment on the part of the processor to produce a good standard product in order to maintain the business.

The Ikalahan began their food processing business on a small scale. We did not know anything about commercial food processing. We only knew that we had some good raw materials and we assumed that there would be a few people who would be willing to purchase our products. At first we produced many sub-standard products before the processors learned how to improve them. We learned later that we began backwards. We should have looked at the potential market before we even began processing but we did not know that. Fortunately we survived that mistake.

In our ignorance, we used whatever packaging was available but some types of packaging did not seal properly and our jellies became mouldy. We could not sell mouldy jelly.

Some of our jellies started to crystalize after they had been on the shelf for two or three months. We didn't know what to do so we went to the Food Technology Department of the University and asked their help. They answered our questions willingly and we solved that problem.

We did not know anything about marketing, either, and we did not know who would be the most likely people to buy our products. We had personal friends who were buying and we naively assumed that we could just display our products anywhere and people would buy them. First, we put our products into little variety stores on consignment but the people who buy in the little variety stores do not buy jams and jellies. The operators of the variety stores did not protect our products. When the bottles were dirty and the labels damaged the managers returned the products to us without paying for them. We lost money.

Finally a business school offered to do a market study for us. Their reports informed us how many people in that city buy jellies and how many we could expect to become our customers. They also informed us, however, that they always shop in supermarkets, not variety stores. The report also told us that the customers want to buy the jellies and jams in 8 or 16 ounce containers and that they were wealthy and well educated. We stopped packing in 4, 6 and 12 ounce containers and hired a designer to make a label to attract those customers. By that time we had also discovered that only glass containers would properly protect the products. With this information we were finally able to do proper marketing but it took several years and many costly mistakes.

One of the purposes of our Food Processing programme, of course, was to provide employment for local people. We needed processors so we trained local women to do the job. In the beginning, some of them processed our products like they cooked in their own kitchen. "A little of this and a little of that and never mind the recipe." The products were not of the proper standard quality. We saw that we would need to have someone in charge of quality control. At first we allowed a cook to do it but never again. "A woman cannot reject her own baby." We found it best to have someone with experience in marketing to do the quality control. Our cooks now follow the recipes very closely and are proud of their very low rejection rate.

When we decided to enlarge our Processing Centre because of increased sales we had our own people make everything possible, including the stoves. We did not buy any expensive equipment because we knew we could not fix it when it broke down. It was simple equipment but it was efficient. We did

take time, however, to design the Centre so that the work flow was smooth and efficient. We have also installed simple gravity powered conveyors to move things around and reduce the cost of having the cooks carry things back and forth.

In order to encourage more families to get involved in processing we once let some of the women process the juice in their own kitchens on a contract basis. That plan lasted for only two months because we could not standardise the quality of the juice they processed. All processing is now done in the Centre but we provide more income for other families by encouraging them to gather the fruit.

We began by processing wild guavas (*Psidium guajava*). Guava jelly was, and still is, a very saleable product but we discovered that we also produced a lot of garbage and it polluted the river. To prevent that we developed recipes for guava jam and guava butter. The three products use almost every part of the guava so there is very little waste. We were still not satisfied, however, so we established a piggery near the Food Processing Centre. The pigs ate the waste and produced manure that was added to weeds and grasses to become organic fertilisers for our orchards and vegetable gardens. The sale of fertiliser produces some additional income. Now, instead of creating pollution, we are creating income. It is not big but every little bit helped.

The community members not only brought guavas to the Centre, however, they also brought other types of fruit which we had never tried before. We tested everything. Some of them were not suitable for processing and some, even though they were suitable, were not saleable. We found one wild fruit named Dagwey (*Saurauia bontocensis*), however, which was both suitable and saleable. We started by producing a dried fruit like raisins. It was very saleable but we had waste juices. We used them to produce Dagwey Jelly and Dagwey Spread. That reduced the waste and now we are working to produce Dagwey Vinegar to reduce it even further.

On another occasion two pre-school boys were playing near the Food Processing Centre and pretended they were cooking the blossoms from one of the hedges (*Malvaviscus arboreus*). A staff member observed them and 'the lights flashed.' The staff member immediately filled a large basket with the blossoms, cooked them to extract the nectar and used the result to make a jelly. It took several weeks to develop the proper recipe but the Centre now sells an excellent Hibiscus Jelly.

Other raw materials which are now being used are ginger (*Zingiber officinale*), Dikay (*Embelia philippinenses*), Passionfruit (*Passiflora edulis*), Santol (*Sandicorum koetjape*), Bignay (*Antidesma bunias*) and others.

All of our fruits are seasonal except for the blossoms that I mentioned a

moment ago. We had to learn to pre-process the juice and the pulp and store them in larger containers. Then when the orders come, we can bring out the stored raw materials and process the finished products. That way the processors can have work 12 months a year, not just during the harvest seasons.

There is some danger, however, in using fruits that are not common. Many customers are afraid to buy new products so it may be necessary to educate the customers. That is usually expensive. Biho-lak, for instance, produces a delicious jelly but few people outside of our society can pronounce the name so we first had to create a new name for it --- Dikay --- but that was still not enough. People are still not buying very much of it. People did not know about Dagwey, either, before we began processing it. It is already selling quite rapidly so sometimes it is not so hard.

In addition to protecting the watershed, the Ikalahan realised that they must also protect the biodiversity of their forests. The forest fruits which they harvest and process were originally food for the wildlife. We had to ask ourselves if our food processing programme was endangering the wildlife.

To answer the question we had a forester estimate how many tons of each fruit were being produced in our forests. Then we compared his estimate with the consumption in the Food Processing Centre. We discovered that we were using less than 10% of each of the fruits. We had established a wildlife sanctuary and implemented a strict hunting season because many of the wildlife were protecting our agriculture from pests. We decided that if the wildlife shared 10% or even 15% of their food supply with us in exchange for the protection we give them, it would be fair and not endanger any of them.

When we first began processing Dagwey we did an inventory of the number of dagwey trees remaining in the forest. There were only 2,000 so we immediately began researching how to propagate it. The research took two years but we have already planted more than 6,000 new trees into the forests. We don't plant them in orchards because it is a forest tree and does not do well in orchards. We recently realised that our consumption of guavas had reached 10% and was growing so we have begun enrichment planting of guavas from choice seed to be sure that we would never go beyond 15%. They, too, are planted in the forest.

We continue to research new products and new ways of processing old products in order to increase both sales and income. Research and Production are only a small part of a business, however. We must also increase sales. We tried several different times to train local people to manage the sales but we finally surrendered. Our people tend to be shy and not very effective in the intense marketing climate of the City. We worked

together with several other small people's organizations and established a marketing group to do the marketing for us. We give the group 20% of their sales. It is cheaper than our former costs and they have increased sales more than 500%.

WHAT HAVE WE LEARNED?

1. We have learned that we should study the market before we try to do commercial fruit processing.
2. We have learned that the customers are always right. Even if we disagree with their decisions, they are the ones that control the money in their pockets. If the customer does not buy, the producer cannot sell.
3. We have learned that we should do everything possible to turn all wastes into new products. Wastes are not only costly, they also damage the environment.
4. We have learned to be creative. Dagwey, Dikay and Hibiscus had never been utilised before. Dagwey and Hibiscus are both selling fairly well but the Dikay is not. We hope that eventually something will happen and the customers will discover it too.
5. We have learned the need to let professionals do the marketing. They can do a better job cheaper.
6. We have learned that the quality of the product is very important. We have also learned that the product needs to be standardised. It is difficult to meet these requirements if the products are processed in the home. There is a need to establish a processing centre where quality can be maintained at all times and a good quality control system must be in place at all times.
7. We have learned that it is unwise to use expensive equipment. People were cooking good products for centuries before the expensive equipment was invented. We know that we need to be as self sufficient as possible.

EXPERIENCE OF PROCESSING AND MARKETING OF VALUE ADDED PRODUCTS IN THAILAND

**Mrs. Nokkaew Muang-Thong, Womens' Association for Household
Industries, Thailand**

Translated by Dr. Benjamas Ratanachinakorn

INTRODUCTION

Pummelo (*Citrus grandis* or *Citrus maxima*) is an economic fruit crop grown in Pichit province which is located in the lower north of Thailand. It is widely grown, mostly in small farms. The produce is sold mainly as fresh fruit in the local markets. Fruit drops either naturally or by pruning and if left on the ground is a serious problem for the grower. Fruit flies lay their eggs on the fallen fruit. The hatched insects will attack the fruits on the trees, which causes premature fruit drop and skin damage to the fruit. These fruit can only be sold at a very low price due to poor quality. To solve the problem, Mrs. Nokkaew Muang-Thong, a fruit farmers's wife, with some friends decided to make use of the dropped or defected fruits. It took them more than a year to develop the acceptable and marketable candy from the pummelo albedo.

MEMBERSHIP

This group started from 7 farmer's wives about 10 years ago. Membership has increased to 45 as the market has expanded. All members of the group have to be able to handle every step of the processing from fruit preparation to packing, which is a hard working process with little mechanical aids. It is hard work and has to start working very early in the morning and finish at 8 pm or later.

INCOME

The income of the members is from daily net profit each day and divided by the member working hours. Each member is paid monthly with a 7% deduction:

- 3% is to pay back the revolving fund to the government or non-government institutions that gave support

- 2% is for working facilities such as electricity etc.
- 1% is for loan to group members
- 1% is for member welfare

MARKETING

Initially, marketing was a big problem: it took the group 1-2 years to launch their business. In the beginning, the pummelo candy was displayed and tasted in the shop at the processing house. They sold their pummelo candy at many fairs and exhibitions organised by the governmental agencies. Now the product has become well known and is sold in local shops, supermarkets and chain stores. They also have a distribution agent to help sell the products.

The group has expanded the line to other fruit candies such as tamarind, lime and other herbs using the pummelo albedo base.

SUPPORT

The group gets support from the Community Economic Development Project, Ministry of the Interior and from the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives through a revolving fund to be paid back within 5 years. Other foreign aid helped build a Centre (located on Mrs. Nokkaew's land) for training women in setting up groups and also networking so that groups can help each other. 240 women have been trained so far.

CONCLUSION

This value added processing group is an example of a highly successful women's group who can turn the waste product into gold. However, it took years before getting to this stage. They have to work so hard with the support and cooperation from both the government organisations and private sectors. Now the group helps others to form strong women groups and this helps strengthen the communities. These groups also hire jobless people and students to work part-time in order to help them get extra pay and take them away from drugs.

MARKETING PRODUCE FROM UNDERUTILISED FRUIT TREES – A CASE STUDY IN WEST BENGAL, INDIA

Dr. S D Chatterjee, West Bengal State Seed Corpn. Ltd., India

The term “underutilised fruit trees” is applied, in the general sense, to a group of fruit trees presently growing in a scattered and unattended way on roadsides, homestead land, wasteland etc. in spite of their potential for intensive exploitation. The fruit plants belonging to this group are in general hardy and grow well even in fragile soil and climate. Since the area under each of these fruit trees is insignificant, they are popularly known as “minor fruits”. Marketing prospects of various types in this group depend largely on their food/nutritional values and multipurpose uses. Relevant information regarding area, production and commercial utility of different minor fruit plants required to design a marketing strategy for this group of crops are very much lacking. Hitherto, no systematic effort has been undertaken to overcome the lacunae. However, the findings of a case study undertaken in the state of West Bengal to identify minor fruit trees and advocate marketing strategy of the produce from them are presented herein.

West Bengal is situated between 27°15'33" N-21o30'29". N and 85°47'54"E-89°51'10".E. It is a small state in the eastern part of India with a geographical area of 88751 sq. km. The State has diverse climate and soil extending from sub tropical perhumid climate with Himalayan Brown Forest soil in the north to coastal soil with tropical humid climate in the south and tropical dry subhumid climate with Red-lateritic – gravelly soil in the west. The inferences drawn based on data generated in West Bengal can be extrapolated to the country due to more or less similar spectrum of edaphoclimatic and agroecological variations obtained in the country as a whole. The study has identified a number of minor fruit trees freely growing in different agro-ecological situations of the state. A list is presented in Table 1.

It is thus evident from the table that minor fruits contribute as yet very insignificantly (1.6%) to the State Fruit Basket. Considering consumers' preference, keeping quality and status of multipurpose use of the produce, the following minor plants have been found to be of marketable worth. The marketing potentiality score of a number of underutilised fruits is given in Table 2. Those minor fruits that are gaining rapid popularity in any category (table fruit, for use in processing industry or in medicinal preparations) have been given the score of 5 (excellent) in this table. Those that have gained no visible recognition in any given category even in unorganised markets of

tiny hamlets have been allotted score 1 (poor). The comparative ratings in between have been marked 4 (good), 3 (fair) and 2 (limited).

BER

It is very hardy with wide adaptability and in-built tolerance to adverse soil and climate. Ripe fruits are highly nutritive and are mostly eaten fresh. A good quantity is being marketed as dried fruit, candies, pickles etc. Good opportunity also exists to prepare squash, juices and butter from Ber pulp. Various parts of the plant have medicinal use also. Many medicines contain Ber extract which is said to be blood purifier and also helps in mitigating indigestion. The powder and decoction prepared from the root are effective against fever, ulcers and old wounds. The stem bark is considered to be remedy for diarrhoea.

BAEL

A hardy plant that thrives even in drier tracts. The fruits are nutritious containing good amount of protein, minerals and very high amount of Riboflavin. Because of its hard shell, mucilaginous texture and numerous seeds, it is less preferred as table fruit. Recently, fresh Sherbat prepared from the pulp is gaining ground in district towns and metropolitan cities. Sweetened fruit conserve (murabba) is a delicious dish in villages. Various plant parts of Bael tree are rich source of useful alkaloids and steroids. The young fruits are prescribed for diarrhoea and dysentery.

AONLA

The fruit plants grow well in a wide array of soil and climate. The scope for fresh fruit intake is very low, although the fruit is highly nutritious and perhaps the richest source of Vitamin C. Tremendous scope, however, exists to produce various value added products like murabba, sauce, dried chips, tablets, jellies, pickles, toffees, powder etc. Aonla is also famous for its diverse medicinal use. Aonla powder is said to be superior to synthetic Vitamin C in treating this deficiency, without any undesirable side effects. Different parts of the plant are useful in treating chronic dysentery, bronchitis, diabetes, fever and in the tanning and dyeing industries. Antiviral properties of plant and fruit extracts provide good opportunity for implant protection.

PALM

Two different types of fruit trees (date and toddy) in the palm group are found growing in a wide range of climate and soil. Due to the high content

of sugar, iron, potassium, calcium, nicotinic acid and the high caloric value of the fruits, the date palm are popular table fruits. The toddy palm, on the other hand, is popular as table fruit only at the young stage. Ripe fruits of toddy are mostly utilised for extraction of juice, preparation of pudding, bread etc. In addition, date palm pulp can be easily utilised to prepare liquor, vinegar and liquid sugar. The sap, taken out of the phloem vessel of date and toddy palm has a good market for consuming as soft drinks and the manufacture of GUR (palm-candy, jaggery). Young (Green) fruit of toddy palm is also known for its property to alleviate insomnia and loss of vitality. Besides this, both the plants have versatile use. The leaves are popular as roofing material in the village huts, paper pulp, broomsticks, hand fan and basket etc. The trunk has been used in making make-shift canoes (country boats), irrigating devices etc., in the countryside.

KARAMCHA

The fruits are rich in Vitamin C, Potash, Calcium, Magnesium, Phosphorous and sugar. Fresh fruits are not liked for direct consumption. Fruit pulps are much utilised for preparing squash, lemonade, jelly, and pickle. Dried pulps dipped in sugar solution are much utilised in variety sweet preparations including confectionery and dessert items. The root and leaf extract relieves gout, enhances appetite and helps maintaining proper level of oxygen in the blood.

Besides the above minor fruit trees, there are several other underutilised minor fruits growing mostly unattended or at best negligibly cultivated like water chestnut, kendu, cape gooseberry etc. They are mostly consumed as edible fruits by tribal people. Some are even processed as flour for preparation of sweet dishes.

MARKETING NETWORK

There are around 3288 markets in West Bengal. In the districts four different types of markets are available *viz.*, Secondary Market, Primary Market, Rural Market and Regulatory Market. In the capital, markets are divided into wholesale, wholesale-cum-retail and retail markets (Table 3).

Very little quantities of fruits from the minor/underutilised fruit trees are consumed at the growers' household. A sample survey revealed that marketed quantity of fruits by the grower varies between 85-95%. Middlemen collect the fruits/plants, plant parts of pharmacological importance either from the door steps of grower or from the rural market and bring them to the Secondary Market for wholesale disposal. Marketable

surplus from the district market comes to wholesale or wholesale-cum-retail markets in Kolkata.

Fresh fruits are sold through retail outlets mostly in cities and district/sub-divisional towns. A good quantity of fruits goes to processing industries. In West Bengal there are 16 large scale industries, 34 small scale, 45 cottage scale and 89 home scale units. The number and description of processing units for fruits in West Bengal is presented in Table 4. A number of these already cater to the postharvest needs of minor fruits as well. Others also have the potentiality of similar use. The approximate total production of processed units a little over 10,000 tonnes, of which 7,500 tones were RTS (Fruti), 2,500 tonnes were chutney and 1,500 tonnes were other produces.

The marketing of plant parts/trees suitable for medicinal use follows a specific channel. Those from the villages are collected by local agents and sold to the wholesale market or direct to the middlemen of medicine industries. The said channel has been presented in the flow-chart, given below.

The medicine industries are mostly located in and around big cities. In West Bengal, out of 31 running industries, 27 are located in Kolkata.

Thus, the data and the discussions presented in this paper lead to the positive conclusion that underutilised fruits have very high marketing potentialities both in respect of harvested end products as well as in respect of postharvest processed products.

Figure 1 Flow chart

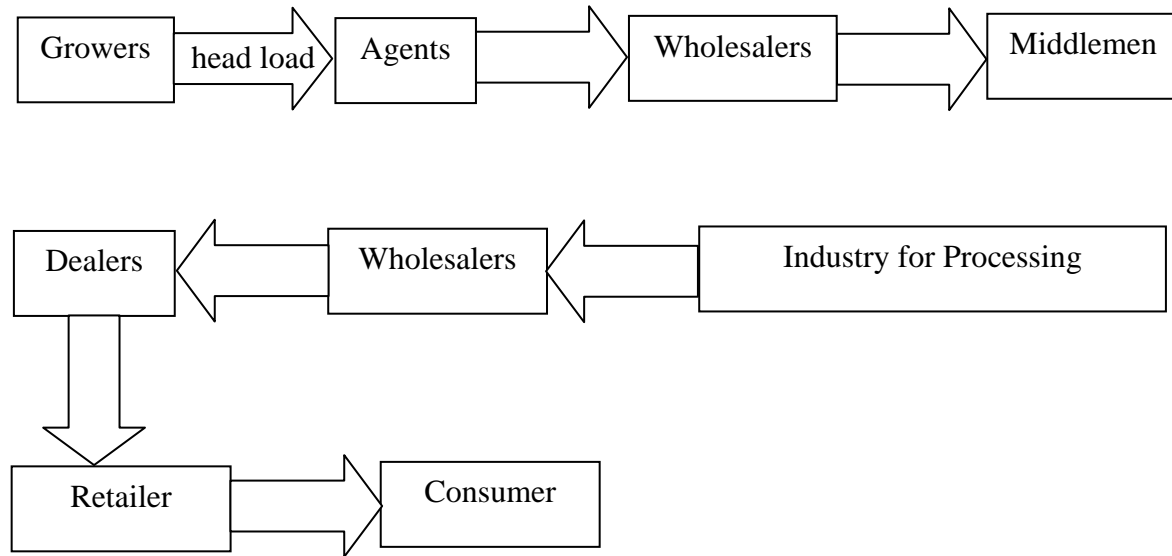


Table 1 Minor Fruit Crops grown in West Bengal, India during 1999-2000

Sl.No.	Vernacular/English name	Scientific name	Estimated Area (ha)	Estimated production (M.T.)	Growing climate
1.	Pomegranate/Dalim	<i>Punica granatum</i>	70	700	Red-lateritic gravelly soil and tropical dry subhumid climate.
2.	Custard apple/Aata	<i>Annona squamosa</i>	125	1250	
3.	Ber / Kul	<i>Zizyphus mauritiana</i> (jujuba)	135	540	
4.	Bael	<i>Aegle marmelos</i>	130	2990	Tropical dry subhumid to tropical humid climate and coastal soil to red-lateritic-gravelly soil
5.	Star apple/Jamrul	<i>Schyzion javanica</i> Var: Alba	125	312	Throughout the state
6.	Jamun/Kaloram	<i>Syzygium cumini</i>	53	212	Tropical humid climate & coastal alluvium soil
7.	Rose apple/Golapjam	<i>Syzygium jambos</i>	55	110	
8.	Phalsa	<i>Grewia subinae qualis</i>	55	82	
9.	Karamcha or Karonda	<i>Carissa Caramdas</i>	260	560	Tropical moist subhumid climate and coastal-alluvium and Red-lateritic soil
10.	Toddy palm/Taal	<i>Borassus flabellifer</i>	240	8400	Throughout the state except in Himalayan brown forest soil.
11.	Date palm/Khenjur	<i>Phoenix dactylifera</i>	245	367	Throughout the State
12.	Carambola/Karmranga	<i>Averrhoa carambola</i>	58	406	

Sl.No.	Vernacular/English name	Scientific name	Estimated Area (ha)	Estimated production (M.T.)	Growing climate
13.	Longan/Ansphal	<i>Euphoria longan</i>	53	790	Tropical humid climate coastal – alluvium soil
14.	Hog plum/Amra	<i>Spondias mangifera</i>	149	238	Throughout the state
15.	Water chest-nut/Panifal	<i>Trapa bispinosa</i>	245	1470	In ponds, ditches, watersheds of tropical moist subhumid climate
16.	Wood apple/Koitbel	<i>Feronia limonia</i>	240	3600	Diverse soil and tropical moist subhumid climate
17.	Aonla/Amlaki	<i>Emblica officinalis</i>	110	110	Throughout the state
18.	Karambel/Chalta	<i>Dillenia indica</i>	122	3050	Throughout the state
Total	Minor fruits		2570	27622	
	All fruits		149686	1750253	

Table 2 Score of Minor Fruit Trees in West Bengal for Marketing Potentiality

Name of the Crop	SCOPE FOR USE.				Other use
	As table fruit	In Processing Industries	In Manufacturing Medicine	Total Score	
Pomegranate	3	3	-	6	-
Custard apple	3	2	-	5	Ice-cream
Ber	4	4	4	12	Wood/Timber
Bael	2	5	5	12	Fuel Wood
Star apple	4	-	-	4	-
Jamun	4	-	-	4	-
Rose apple	4	-	-	4	-
Phalsa	4	1	-	5	-
Karamcha	3	5	1	9	Chemical for cleaning, also cooked as sour curry, chutney
Toddy palm	3	5	1	9	Soft Drink/Gur
Date palm	5	5	-	10	Do
Carambola	1	2	-	3	-
Longan	3	2	-	5	-
Hog plum	1	3	-	4	-
Water chestnut	3	1	-	4	-
Wood apple	1	3	-	4	-
Aonla	1	5	-	11	Botanical pesticide
Karambel	1	1	5	2	Cooked as sour curry in parts of eastern India

1 = Poor 2 = Limited 3 = Fair 4 = Good 5 = Excellent

Table 3 Nutrient content of some important underutilised fruits

Nutrient	Aonla	Date Palm	Ber	Bael	Karamcha
Moisture %	81.2	2.0	59.0	61.5	18.2
Protein %	0.5	2.0	0.8	1.80	2.3
Fat %	0.1	2.0	0.1	0.39	9.6
Minerals %	0.7	2.0	0.5	1.70	2.8
Carbohydrate %	14.0	-	12.8	30.60	67.1
Vitamin C (mg/100g)	700-1200	-	500-600	15-20	-
Energy (cal/100gm)	59	315	55	129	364
Riboflavin (mg/100g)	-	30	-	1191	-

Table 4 Markets in West Bengal

	Name of the Market	Numbers
A.	In districts	
1.	Secondary Market	159
2.	Primary Market	2244
3.	Rural Market	681
4.	Regulated Market	38
B.	In big cities	
5.	Wholesale Market	20
6.	Wholesale-cum-Retail Market	35
7.	Retail Market	111
	TOTAL	3288

Table 5 Fruit Processing Units in West Bengal, India

Sl. No.	Size of the plant	Number of units
1	Large scale	16
2	Small scale	34
3	Cottage scale	45
4	Home scale	89
	TOTAL	184

TROPICAL WHOLEFOODS - FAIRLY TRADED HEALTHY FOODS FROM UGANDA, BURKINA FASO & PAKISTAN

Mr. Adam Brett, Tropical Wholefoods, UK



HISTORY (1990-2002)

Initial Work Uganda
First Exports Uganda
Initial marketing efforts, UK healthfood sector
Initial Contact with Burkina Faso
First Sales to Traidcraft
Ugandan Export Award won by FON
First Sales to Oxfam
Worldaware Award won
Initial work in Pakistan
Test exports from Pakistan
First Full Consignment from Pakistan

PRODUCTS

Sourcing innovative fair trade ingredients to enable development of:

- organic products
- innovative snack foods
- fruit mixes, muesli & breakfast cereals
- healthy confectionery



PROJECTS

Uganda: Fruits of the Nile

Tropical Wholefoods' partner works with about 80 farmers groups in 7 districts of Southern Uganda providing training in solar drying and fruit processing.

Each year about 70 tonnes of dried banana, pineapple, mushroom, papaya & chilli are exported from Uganda as a result of FON's work.

All dryers are totally solar powered, and all farmers are encouraged to use totally organic methods of cultivation.



Burkina Faso: Cercle de Secheurs

An independent organisation, founded prior to intervention from TW, by another ATO called CLARO. We have given relatively little: some advice, some tips on technology. However we are their largest customer, purchasing about 30 tonnes of product from them in 2001.



Pakistan: The DFP Gilgit, Northern Areas

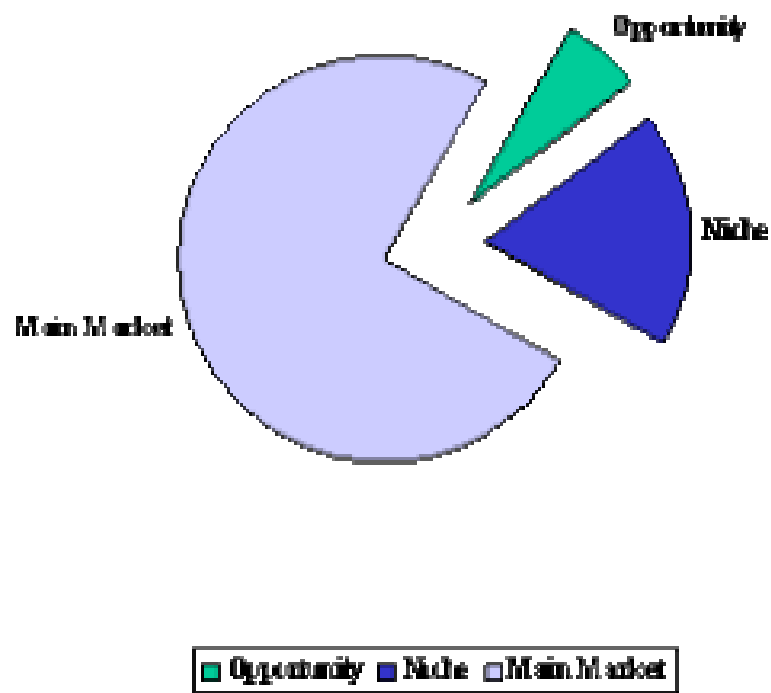
TWs most recent project collaboration. A small business in Gilgit, given 'seed-corn' funding of about £50,000 by AKRSP.

Now exporting 30 tonnes of apricots, with capacity for 150-200 tonnes and product diversification including apples, dried mulberries, strawberries and nut products.

TECHNOLOGY

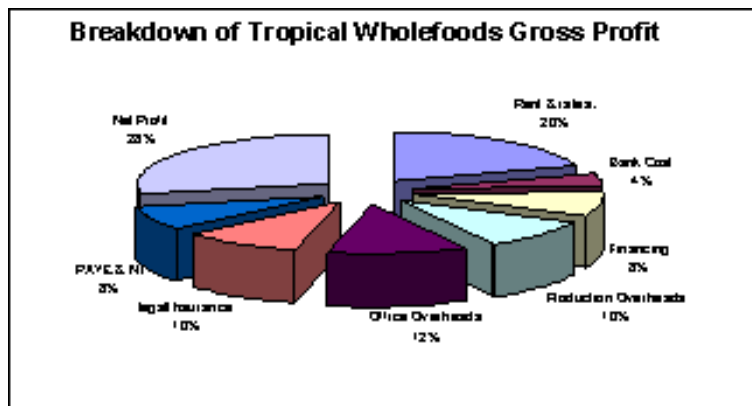
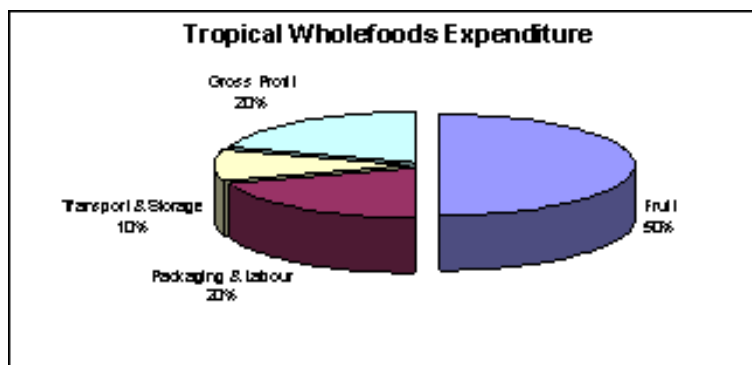
Appropriate, sustainable technologies that are not dependent on petroleum. Local materials, locally acceptable locally supportable. Carefully tested, by local people, not foreign consultants. Designed to meet local needs, not impose technology on those intended to use it. Market Driven.

- It is seldom possible to compete into a well established market in a first world country
- The skillful business-person works to find the **opportunity**, which is usually a sub-niche, a developing new product opportunity within the larger whole
- All opportunities are limited in size.



FINANCES

Fruit	£250,000
Packaging and Labour	£100,000
Transport and Storage	£50,000
Gross Profit	£100,000
Rent and Rates	£20,000
Bank Cost	£4,000
Financing	£8,000
Production Overheads	£10,000
Office Overheads	£12,000
Legal/Insurance	£10,000
PAYE and NI	£8,000
Net Profit	£28,000



MOTIVATIONS

Our personalities contain a strong ameliorative desire to ‘make better’, ‘improve’ and change.

This desire is linked to a desire for justice in some intangible sense, and also a pleasure in striving to solve complex problems.

Interestingly we are not motivated by charity, which gives to those identified as ‘needy’. Our focus is on those who are capable. Those who can effect change, work and build.

We enjoy ‘gardening’, watching over a number of years as a business grows up, where before there was nothing.

We enjoy the magic of capitalism, which allows us to walk into shops in London, New York, or Tokyo, and see our products on sale via channels processes we do not even understand.

CONCLUSIONS

Tropical Wholefoods will continue to:

- create partnerships with ethical trading businesses in Europe
- develop innovative exotic food products to meet market demand
- collaborate with overseas partners to develop their own businesses
- expand markets for fair trade foods.

STATUS REPORTS ON PROCESSING AND MARKETING OF UNDERUTILISED FRUITS OF BANGLADESH

Mr. Sreekanta Sheel and Dr. S M Monowar Hossain, BARI, Bangladesh

INTRODUCTION

Bangladesh is an agro-based country where agriculture is the main occupation of the majority of the people employing 69% of the labour force in the country. This sector directly contributes about 32% of the GDP of Bangladesh. Total cultivated land of Bangladesh is 14.85m ha of which fruit production occupies about 0.67% of total cultivated land (BBS, 1998). The *per capita* fruit consumption is estimated at 3.3 kg/yr being the lowest in comparison with other neighbouring countries indicating a poor balanced diet against the requirement of vitamins and minerals. The present area under fruit cultivation is estimated at 0.18m ha producing 0.33m tons/yr where mango occupies about 28% of the total area followed by banana (22%), jackfruit (17%), pineapple (5%), guava (6%), papaya (5%), and other fruits (15%) (BBS, 1998).

Fruits are more or less seasonal in production and therefore, often form a glut in the market in their harvesting seasons. The price paid to the growers during the peak period is often low and conducive to their investments. The commodities in their fresh state are very much vulnerable to heavy postharvest losses, both in quantity and quality during transportation and marketing. Estimated postharvest loss of fruits is reported to be 20-25%. For highly perishable fruits and vegetables, the loss may go as high as 40%. The country produces fruits like golden apple, palmyra palm, litchi, ber, bael, carambola, wax jamboo, jamun etc. are termed as minor fruits in the context of Bangladesh. The majority of minor fruits may be considered as underutilised fruits as given in Table 1. These underutilised fruits are grown and sold in the market almost everywhere in the country and can be used as raw materials for processing. Most of these fruits have high medicinal values and are moderate to high in vitamin and mineral content. Among these fruits, processing technologies of a few numbers of fruits have been established, some are under establishment and the rest are not processed at all. So, if these perishable underutilised fruits are processed into shelf-stable products at commercial level, the financial return is expected to be more for the growers as well as the postharvest loss will be reduced to a great extent.

The demand for different fruits is increasing day by day but supply remains stagnant. So, there is a wide variation in pricing level between producers and

consumers during the harvesting period. This occurs due to the inefficient marketing system.

STATUS OF PROCESSING TECHNOLOGY

Traditional uses and processing practices of underutilised fruits

In most cases, the underutilised fruits are consumed after some processing or with different kinds of additives depending on the fruit. The products thus prepared are not usually shelf-stable for a long period and are consumed just after preparation. Some fruits are consumed as fresh fruit directly. The traditional consumption practices of some underutilised fruits are as follows:

Golden apple

The fruits are peeled and sliced. Salt and red chili powders are mixed with the slices before consumption. Usually the street hawkers perform this processing operation.

Muskmelon

Due to the low sugar content after peeling and slicing, the fruit is sometimes consumed with addition of molasses (concentrated juice of sugarcane). The fruit is also consumed fresh.

Wood apple

Apart from direct consumption, the fruit is consumed as *Sharbat* (a traditional fruit drink) prepared by pulping, followed by adding sugar. In some cases, milk is also added to the product. Tender bael, having a higher medicinal value, is processed into preseves. The tender fruit is sliced into thin pieces and dried in the sun. The dried product is stored round the year. Juice extract from the dried, tender, bael fruit is used orally for treatment of constipation and dysentery.

Ber

Sweet varieties of the fruit are consumed directly and sour varieties are consumed with addition of salt and red chilli powders. The dried fruits are made into chutneys and pickles.

Elephant apple

The fruit is used in preparation of chutney and pickle. It is also used as an additive in pulse soup.

Rose apple

A mash is prepared after bruising the fruit with thumb pressure and then salt and green chilli powders are mixed. The product thus obtained is consumed as a snack. The sweet varieties are also consumed directly. The fruit is traditionally processed into jelly.

Olive

Olive is processed into oil pickles and chutneys. Also, the fruit slices are used in preparation of pulse soup.

Elephant foot apple

The fruits are bruised and pulp is extracted. Salt and red chilli powders, beet salt etc. are mixed to the pulp before consumption.

Passionfruit

This fruit is now underutilised in Bangladesh. It is being cultivated mainly in the hilly regions. The fruit is consumed as *Sharbat*.

Palmyra Palm

The fruits are peeled and pulp is removed through mashing with addition of water followed by pressing with a sieve. The pulp thus prepared is used in the preparation of many types of food items like *pitha*, *halwa* etc. The seed portion of the fruit when tender is consumed as a popular snack item.

Tamarind

It is processed into chutney, sauce etc. The seeds are used as gummy materials and for other industrial purposes.

Aonla, Horitoki, and Boyrah

These three fruits are together known as '*Triphola*'. The fruits have a high medicinal value. The juice extract is used in the treatment of stomach and heart diseases. The dried fruits are bruised and soaked in water for overnight and the extract is then separated through a muslin cloth.

Appropriate Processing Technologies for Underutilised Fruits Developed by Bangladesh Agricultural Research Institute (BARI)

Jam

Single fruit jam is prepared from palmyra palm, golden apple, wood apple, musk melon and water melon. Mixed fruit jam is also prepared by mixing the pulps of papaya, golden apple and guava. The standard jam making procedure is used in the preparation of the products. The products are prepared using different ratios of fruit ingredients and sugar giving emphasis on using less or no external pectin. Sensory evaluation revealed that the formulations judged best when the ratios of sugar and pulp solid were 12, 15, 4, 16, 14 and 18 in cases of palmyra palm, golden apple, bael, musk melon and water melon, and mixed fruit jams respectively.

Jelly

Single fruit jellies from golden apple and malta (sweet orange) juice are prepared using the standard jelly making process. A mixed fruit jelly from papaya, golden apple and guava is also prepared. The products are prepared using different ratios of juice and sugar giving emphasis on using less or no external pectin. Jelly formulations evaluated best when the ratios of sugar and juice solid were 19, 12.5 and 20 in cases of golden apple, malta and mixed fruit jelly from papaya, golden apples and guava respectively.

Fruit cheese

Fruit cheeses are prepared from guava and golden apple singly. Here, juicy pulp from the fruits is used. Butter and salt is also added. The product is prepared by cooking the mixture of fruit pulp, sugar, butter and salt up to a TSS level of 80-90°B. According to sensory evaluation, fruit cheeses prepared using sugar and pulp solid ratios of 14 and 15 in golden apple and guava cheeses respectively have been judged best.

Chutney

Chutney is prepared by mixing different ratios of fruit pulps, sugar and spices. Different ratios of sugar and pulp solid are also used. The product is prepared from golden apple, elephant apple, tamarind, aonla, elephant foot apple and olive singly. Two types of mixed fruit chutney are prepared from a mixture of olive and tamarind and a mixture of olive and elephant foot apple. The final TSS is maintained at 60-67°B level in the chutney formulations. Sensory evaluation revealed that the formulations judged best when the ratios of sugar and pulp solid were 17, 19, 1.62, 10.5, 27, 7.2 and 18 in cases of golden apple, chalta, tamarind, wood apple, olive, olive-tamarind and olive-wood apple chutneys respectively.

Preserves and Candies

Preserves and Candies are prepared from guava, carambola, aonla and tender palmyra palm. Standard preserve and candy making procedures are applied in the preparation. The preserves are packed in glass bottles and candies are packed in polypropylene bags.

Fruit drink (Ready-To-Serve fruit beverage)

The unfermented beverage is prepared from the combination of fruit juice, sugar and citric acid. Its TSS is maintained at 15°B level. The drinks are packed in glass bottles. Single fruit drinks from aonla, elephant foot apple and wood apple are prepared. Also, a mixed fruit drink is prepared from the combination of 'horitoki', aonla and boirah. Fruit drink formulations were evaluated best when the ratios of sugar and juice solid were 9, 2.3, 13.5 and 12 in cases of aonla, bael, wood apple and mixed fruit drink from 'horitoki' aonla and boirah respectively.

Pickle

Oil pickles from olive, golden apple, aonla are prepared. Also a mixed fruit pickle is prepared from olive, aonla and ber. After partial salt fermentation, fruit slices are mixed with different spices, salt and sugar. The mixture is then cooked in oil to a sufficient consistency, cooled and glass bottled. According to sensory evaluation, golden apple pickle prepared using percentages of salt and maintaining percentages of acidity of 2.3 and 1.00 respectively were judged as the best formulation. In the case of olive pickle, the best formulation was found when these values were 3.0 and 2.5 respectively. The best formulation was obtained in the case of aonla pickle while these values were 2.7 and 1.60 respectively. In the case of mixed fruit

pickle from olive, aonla and ber the best one was found when these values were 2.70 and 2.00 respectively.

Pectin Content

The crude pectin content of tamarind, ber, elephant foot apple, olive, golden apple, guava, wood apple, orange pulp, roselle and green papaya are 0.31, 0.59, 0.48, 0.43, 0.58, 0.62, 0.32, 0.96, 1.90, 1.02% respectively. The data revealed that these indigenous fruits are rich in pectin and hence there is a great prospect for using tamarind, ber, wood apple, olive, golden apple, guava, roselle and green papaya in the preparation of jam, jelly, chutney, fruits cheese etc. with the addition of less or no extra pectin.

Commercial Processing of Fruits

The existing fruit and vegetable processing industries in the country mainly produce jam, jelly, squash, ready-to-serve fruit drinks, ketchup and pickle. The present situations in the industries are as follows:

- i. They produce food items mainly from mango, pineapple, orange, and some other exotic fruit commodities. In some cases, the products are prepared using only flavours and emulsions instead of original fruits. From the underutilised fruit groups, olive is processed into oil pickle and chutney; ber and tamarind are processed into chutneys.
- ii. A small number of fruit and vegetable processing industries use very few numbers of indigenous fruit commodities for processing into jam, jelly, fruit drink and pickle. Vegetables, except potato, are not processed at all in the existing industries, although, there is a good prospect for processing these commodities. The small number of seasonal fruits is not sufficient in efficient running of an industry. As a result, a considerable time of the year is spent idly in these factories.
- iii. Most of the industries are located only in and around big cities especially in the capital city where fruit and vegetables arrive through different channels of marketing. The freshness of the commodities deteriorates and postharvest loss occurs to a great extent due to excessive handling and transportation in the marketing process. Also the producers of fruit and vegetables are not in direct contact to the processing industries and hence, they do not get the profitable price for their produce.
- iv. The quality of processed products produced by the majority of fruit processing industries is not improved in comparison to the foreign products. As a result, foreign products dominate the local market.

MARKETING STATUS OF FRESH FRUITS

Most fruits are sold by farmers immediately after harvest because of farmers' cash needs and the lack of storage facilities. Most of the farmers in all regions sell fruits immediately after harvest. They use headload and rickshaw vans to carry the products to markets. Traders, wholesalers and buyers use rickshaw van and trucks. The majority of the farmers sell their products in weekly markets and the rest of them sell them in daily markets. Farmers get price information from other farmers and traders.

Marketing channels and involvement of intermediates vary among regions. The four major marketing channels are:

- i. producer-trader-wholesaler-retailer-consumer
- ii. producer-trader-retailer-consumer
- iii. producer-retailer-consumer
- iv. producer-consumer

The commission of intermediaries varies by region and crop. There is no systematic way of fixing the charge. The margin between the trader's price and the retail price is very high.

The farmers and traders encounter various problems during marketing of fruits. Farmers cannot get a fair price for their produce due to the influence of local brokers, immediate cash need and lack of storage facilities. A high price gap is found between the producer and consumer level, this discourages the producers from producing more in future. Most of the fruit farmers face similar problems of perishability, storage facility, weighing system, grading and information. Price instability and high transport costs are the most important problems for intermediaries. The other problems in the fruit marketing system are inadequate capital, lack of processing industry and weight loss.

MARKETING STATUS OF PROCESSED FRUITS

Market Characteristics

Processed products from fruits are consumer products. The present market for these products is a sellers' market dominated by a number of firms. Consumers have choices of different quality and prices. Producers with appropriate marketing strategies are receiving market acceptance in the domestic market. The market for processed fruit products is becoming highly sophisticated and consumers are becoming more quality conscious. Major local markets include Dhaka city and other key cities. Some producers distribute their products to the districts and major Upazila towns. Products

have a good demand from hotels, restaurants, student's halls, canteens and cafeterias. Apart from a growing domestic demand, the government is encouraging the export of processed foods which is important for this sector. Some fruit processors claim to export their products to Canada, USA, Middle East and European Countries, Australia, India, Nepal, and Bhutan. The leading export products are pickles, chutneys, canned fruits, fruit juice drinks etc. Buyers generally look for the right colour, flavour and prices. Proper packaging is also vital. Products for the export market are subjected to requirements dictated by the exporter or foreign buyers.

Market Channels

Processed fruit products in the local market move from processors to consumers through a chain of wholesalers and retailers. Distribution to the export market is through direct exporting or through other trading companies.

Competition

Competition for a share in the local market comes mainly from large food processing companies such as Agricultural Marketing Company Ltd. (PRAN) and Ahmed Food Products. Also a large number of fruit processing enterprises are trying to penetrate the market. There is competition from imported brands however the capital city is invariably the market leader in processed food products. Although the fruits are grown in many regions of the country, the processing activities are almost limited to the local producers.

Product Quality

Quality of products is ensured through using appropriate raw materials, the right type of equipment and qualified technical personnel. Bangladesh Standard and Testing Institution (BSTI) standards and rules are followed to ensure high quality.

Pricing

Pricing is usually set using the cost-plus method. The following generally make up the cost of the product: 70-80% for raw materials, 7.5-15% for direct labour and 10-20% for overhead and administrative expenses.

Sales/Product Promotion activities

The manufacturers undertake advertising through the mass media such as newspapers, radio and television to popularise the products among the consumers. Leaflets are also used to make consumers aware and attracted to the products. Exposure to the market has also improved with the increase of annual trade fairs like International Trade Fair, Agri-trade Fair, National Food Fair, Youth Fair, Industry Fair etc.

PROSPECTS OF PROCESSING AND MARKETING OF UNDERUTILISED FRUITS

Underutilised fruits of Bangladesh are highly rich in vitamins and minerals. These fruits also have high medicinal value which can be processed into various types of medicated food. At present, a number of the underutilised fruits are used in the preparation of herbal medicines that are often used in the treatment of common diseases and nutrient deficiency syndrome. But this medicine is not tasty like snack food items. Therefore, if the fruits are processed into medicated food having tasty and delicious characteristics, the food item can contribute to naturotherapy. The fruits can be preserved in a variety of ways at home, cottage, small and large scale industry levels. The most common methods are pickling, salting, fermenting, drying and dehydration, preservation in sugar, refrigerating, freezing, canning and bottling. Table 1 shows the list of selected underutilised fruits together with data which might be helpful to consider in processing them.

There is an ample scope for exporting the fruit products in the Middle East, USA, UK, Australia and European countries. However, due to lack of improved formulations of fruit, the country is being deprived of earning valuable foreign currencies.

Table 1 Processing possibilities of underutilised fruits of Bangladesh

Bengali Name	English name	Scientific Name	Height of Season	Processing Possibilities
Ata	Bullocks heart	<i>Annona reticulata</i>	Jan-Mar	Jam, butter, juice
Amloki	Aonla	<i>Emblica Officinalis</i>	Oct.-Feb	Pickle, preserve, dried, candy
Amrah	Golden apple	<i>Spondius pinnata</i>	Jul-Dec	Jam, preserve, pickle, candy, chutney
Bangi	Muskmelon	<i>Cucumis melo</i>	Mar-May	Juice, preserve, jam, candy, canned in syrup
Bel	Wood apple	<i>Aegle marmelos</i>	Dec-Jul	Preserve, jelly, jam, squash
Boroi/ Kul	Ber/Jujube	<i>Zizyphus jujuba</i>	Jan-Mar	Jam, preserve, pickled, candy, chutney
Chalta	Elephant apple	<i>Dillenia indica</i>	Sep-Oct	Jam, jelly, pickle, chutney
Dumur	Fig	<i>Ficus recemosa</i>	Feb-May	Jam
Jaam	Rose apple	<i>Syzigium cumini</i>	May-Jul	Jam, jelly, juice, squash
Jalpai	Olive	<i>Elaeocarpus floribundus</i>	Sept-Dec	Pickled, chutney
Kathbel	Elephant foot apple	<i>Feronia limonia</i>	Oct-Jan	Jam, pickle, chutney
Khejur	Date palm	<i>Phoenix sylvestris</i>	Nov-Feb	Sugar cake from juice collected from tree-stem
Passion phol	Passion fruit	<i>Passiflora foetida</i>	Aug-Oct	Jelly, squash, canned juice, frozen
Jambura	Pomello	<i>Citrus grandis</i>	Sept-Oct	Preserve, juice
Tok Ata	Soursop	<i>Annona muricata</i>	Jan-Mar	Juice, frozen, jam, preserve
Tal	Palmyra palm	<i>Borassus flabellifer</i>	Aug-Sep	Jam, squash, candy from tender seed
Tarmuj	Water melon	<i>Citrullus vulgaris</i>	Mar-Jun	Frozen, candy, pickle, jelly, squash, canned in syrup
Tetul	Tamarind	<i>Tamarindus indica</i>	Jan-Mar	Candy, preserve, jelly, juice, sauce

CONSTRAINTS IN PROCESSING AND MARKETING OF UNDERUTILISED FRUITS

Despite the products created by fruit processing, producers face a growing number of constraints. The market for processed products is becoming fiercely competitive. Some of the constraints are as follows:

- lack of readily available modern technologies suited to local conditions
- lack of adequate and constant raw material supply
- the shift from subsistence farming to cash cropping
- increased reliance on the part of many fruit product producers on imported raw materials (preservative, colour, flavour, thickeners, emulsifier, etc.) which results in most of the cost of production
- most of the modern and special processing equipment has to be imported and is thus expensive and difficult to maintain
- for cottage and small scale industries, promotional activities are limited due to the high cost of advertisement in mass media
- in the domestic market, there is stiff competition from multinational companies
- the low and fluctuating nature of demand, high taxation and absence of transport make serious bottlenecks in marketing fruit products
- the value-added tax imposed by the government to the processed food industry
- most of the fruit processing industries are lacking storage facilities prior to processing the fruits, as a result, and due to the higher perishable nature of the fruits, postharvest losses are occurring
- packaging materials are costly and average fruit processors cannot afford to pay the high cost of packing fruit products.

POSSIBLE EXCHANGEABLE VIEWS AMONG THE PARTICIPATING COUNTRIES

- i. For quality processed products, there is a need for quality fruits having higher nutritional and medicinal values. Hence, high quality germplasm of fruits should be collected and exchanged among the participating countries for availability of the quality fruits.
- ii. The protocols for processed products from underutilised fruits should be prepared, and distributed among the participating countries.
- iii. There is an urgent need to develop new fruit products from the underutilised fruits. The commodities should be prioritised on the basis of availability and undertaken for product development.

- iv. Nutritional quality and medicinal value of underutilised fruits of the participating countries should be assessed. Priority should be given to the development of medicated food products from underutilised fruits with higher medicinal value.
- v. Research work should also be undertaken on the removal of unexpected taste (e.g. astringency of elephant foot apple, aonla ber; excessive acidity in tamarind; bitterness of palmyra palm etc.).
- vi. To support the export in a systematic way, mission-oriented research among the network countries has to be put in place, right from good quality raw materials to storage and processing by applying good manufacturing practices to meet international standards.
- vii. Manpower development programme for researchers should be undertaken among the network countries where exchange of developed processing technologies should be given more emphasis.
- viii. The marketing system of fresh and processed fruits is not properly developed in Bangladesh. Hence, there is an urgent need to develop the system by utilising experience of developed marketing systems in different countries of the network.
- ix. There is a need for feasibility studies, market intelligence, and business advice for marketing of fresh and processed fruits. Technology for manufacture of cottage and small-scale industry level fruit processing machinery should be exchanged among the network countries.

CONCLUSION

Bangladesh produces a large number of underutilised fruits with high potential for processing. The majority of them have high medicinal value. Production of fruits should be increased with priority on the basis of nutritional and medicinal values. Greater emphasis should be given to the development of medicated food products from the fruits. The processing industries should establish a contract production system to ensure quality of raw materials *viz. a viz.* the processed products to meet local and global market demand. Also, the entrepreneurs should give emphasis to the production of medicated fruit products.

The export market for processed fruit to Europe, America, Middle East, Indian sub-continent appears to be brighter than that of other industrial products. There is a good prospect for establishing the fruit industry in the country. Liberal industrial policy, favourable investment environment, cheap labour, availability of suitable land with reasonable cost, water resources etc. contribute positively towards establishing these industries. For the purpose of exporting the products there should be a clear-cut policy to establish fruit processing industries in the country. The research and development should

be enhanced, resources from the research organisations, universities and industries should be pooled together to develop effective know-how capability to establish successful fruit processing industries for consumption at home and for export.

Promotion of household and village industry will encourage sufficient local production for eventual entry into different markets. Small-scale industries are the backbone of the country. This is particularly so, in the case of fruit processing industries. Promotion of fruit processing in its proper perspective in the private sector will open up new horizons in the economic development of the country. This will enhance food security, employment and income of the people of the country. The fruit processing industry can play an important role in prevention of postharvest losses and value addition to most products.

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PROCESSING AND MARKETING OF UNDERUTILISED FRUITS IN INDIA

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INTRODUCTION

Today, there are several plants known to Man, useful as food, clothing, shelter, etc., that were domesticated and widely cultivated by primitive man. Modern man has neither domesticated the remains nor has he identified any new food plants in recent times, which are widely acceptable. This report on plant production and marketing provides promise for improving the quality of life in tropical areas like India. India contains a high proportion of the low income population that requires balanced food and nutrition at affordable prices (Pareek, *et al.*, 1998). Hence this report is addressed to those government administration, technical assistance personnel and researchers in agriculture, nutrition, and related disciplines who are concerned with helping in a more efficient and balanced exploitation of biological resources of underutilised fruits in India.

The survey conducted by earlier workers in India (Au and Rab, 2000) projected the tremendous potential for introducing new products of considerable commercial and nutritional status (ber, tamarind, jamun, karonda, jackfruit, passionfruit, annona, phalsa etc). The task of weighing the technical details against economics, marketing needs, available resources and processing capabilities of underutilised fruits in India has been discussed to a greater extent.

PROCESSING AND MARKETING OF UNDERUTILISED PRODUCTS

Popularity of major fruits, to some extent, has constrained the growth of new minor fruit commodities as well as the fruit industry in this sector. This may also be due to little production of underutilised fruits in India. Hence, appropriate marketing infrastructure, with support from the processing industry, needs to be developed for popularisation of underexploited fruit species. Many of the Indian native communities, depending on indigenous wild fruit flora for their livelihood and income supplementation, bring a variety of fruits and their products for sale in the Indian market. In this regard, the Indian National Commission on agriculture has suggested the collection, processing and marketing of the minor fruit products, which can generate employment for over 10 million people every year.

Marketing of the underutilised fruit sector in India has no definite channels. According to Rajat (2000) the tropical fruits distribution has been through two prominent outlets: one is the supermarket channel and other is the shops run by retailers of ethnic origin. Some of the fruits available through such shops are aonla, jamun, wood apple, karonda, passionfruit, pummelo, mangosteen, jackfruit, ber and bael but very occasionally other underutilised fruits are available.

There are many difficulties in popularising underutilised fruits at market and consumer level because of a number of reasons: primarily consumer ignorance about these fruits, their mode of usage, expectation of sensory qualities, and mode of storage and ripening. Hence there is a need to give guidance to consumers by means of accompanying pamphlets about aforesaid aspects. Major fruit distributors (both wholesale and retail), failure to market underutilised fruits and their products in the most optimum way by displaying the quality, price and information results in ignorance about the fruit texture, colour, flavour, and optimum maturity before consumption by consumers. Finally, there is a lack of sustained and ongoing research by producers in exporting countries and importers in the developed countries.

Production, postharvest handling and processing of underutilised fruits practiced today perpetuate heavy losses. Inadequate infrastructural facilities cripple marketing prospects. Low production of underutilised fruits results in lesser yields of processed products, thereby increasing the production cost during processing. To overcome these problems, the development of technologies is required urgently to minimise the losses during postharvest handling and also technologies suitable for specific processing purposes, product development and storage of fresh and processed products.

CONSTRAINTS IN MARKETING OF UNDERUTILISED FRUITS

- a. Consumers do not know many of the underutilised fruits which are unpopular compared to major fruit
- b. Non-availability of information on processing, packaging, storage technology and transport
- c. Non-availability of scientific resources for testing, valuation and postharvest management of different underutilised fruits
- d. Non-existence of the marketing network and infrastructure facility for underutilised crops.

Packaging at the Market (Khurdiya 2001 a)

The following should be considered during pre-packaging of perishable fruits for distribution to retail outlets in the market area:

- a. Efficiencies are possible through high volume operation with automated or semi-automated equipment
- b. Freshness of pack should be retained with little chance of deterioration or decay during retail display and sale
- c. Knowledge of the market intelligence is essential so as to plan the supply to meet the market requirements
- d. The opportunity for advertising and promotion of items in abundant supply.

Packaging at shipping point (Khurdiya 2001 a)

- a. The greater availability and lower cost of labour in production areas as compared with the urban area where most of the large re-packers and wholesalers are located
- b. Reduced shipping weight as a result of trimming unusable parts of the product before shipment (e.g. removal of hull and seeds in tamarind).

UNDERUTILISED FRUITS

There are many underutilised fruits and the majority of them are not well known. Some of them are given below:

Jackfruit (*Artocarpus heterophyllus*)

Jackfruit production is seasonal and the exact production in India is not known, since there is no organised cultivation of this fruit except in a few places: Assam and Bihar (Ghosh, 2000). In South India, there are no fruit producing orchards but jackfruits are grown as single trees on bunds or borders. Most of them are of seedling origin. Recently, the plantation of these fruits is maintained by State Horticulture and Forest Departments of Karnataka, Tamil Nadu, and Kerala.

The jackfruit yields once a year. The majority of fruits are marketed locally by farmers. Some of them are brought to the roadside or local markets where they are sold for Rs.30-50 per fruit based on the fruit quality and size.

Jackfruits which are not of good quality are locally utilised for chip making. These chips are available at a cheaper cost compared to potato chips. In addition to chips, other products prepared from jackfruit are papads and halwa. These products have good keeping qualities. Halwa is prepared by adding fully ripe jackfruit flakes, jaggery, vegetable oil, basin, kishmish, and

cashew and permitted colours. Jackfruit processing was standardised at CFTRI (Berry and Kalra 1998) to produce a variety of products like canned jackfruit bulbs in syrup, squash, raw jack pickle, roasted jack seeds, jack seed flour and candied jackfruit.

Pummelo (*Citrus grandis*)

Unlike other citrus fruits, pummelo is not grown on a commercial scale in India. Pummelo is hardy and can withstand both biotic and abiotic stresses compared to other citrus species. The major sources of pummelo fruits are by one or two trees planted in farmers' fields or in their backyard. The fruit yields two seasons in a year February-March and September-October. The fruits are harvested and sold locally on the roadside for a price of Rs.10-50 depending on quality.

Pummelo has a very thick rind and high juice content. It can be stored for prolonged periods and transported with ease. Hence, pummelo could be used by the processing industry for preparation of jam, jellies and concentrated fruit juices if available in larger quantities.

Mangosteen (*Garcirna mangostanta*) and Durian (*Durio zibethinus*)

Mangosteen and durian are very popular in some of the South East Asian countries like Philippines, Indonesia, Thailand and Malaysia. In India, they are not popular and less known to consumers. Some of these plants are to be found in Fruit Research Stations at Kallar and Barliar, Directorate of Horticulture, Tamil Nadu and some farmers' fields at Kuttralam in Tamil Nadu and State Horticulture department farms in Kerala. The fruits are harvested during November and are sold at local markets for Rs.10/- per fruit for mangosteen and Rs.200-400/- for durian. Due to less availability and higher cost of these fruits, no efforts were made to process and popularise, although processed products like fruit bar, toffees and chocolates are very popular in Philippines and Malaysia.

Processing of Bael (*Aegle marmellos*)

Fruits become fully mature 8 months after fruit set. At this stage, the shell changes from deep green to light green and the flesh (pulp) from light yellow to deep yellow (Khurdiya 2001 a). There is no standard practice for the grading of bael fruits. Injured fruits are discarded and healthy ones are graded according to size. Fruits are mostly packed in gunny bags and sometimes in baskets for transportation and marketing. Care should be taken that fruit should not develop any cracks while packing, transportation and

marketing otherwise it will become spoiled due to fungal infection. Storage life depends on the stage of harvesting. Fruits harvested at full maturity (light green colour) can be stored for about 15 days, whereas those harvested ripe can be stored only for a week. In cool storage, they can be stored for about 3 months at 9°C and 85-90% RH.

Processing products of bael

Preserve

Mature green fruits are most suitable for making preserve. In order to prepare preserves, a special strong knife will remove the hard rind of the fruit. The fruit is sliced into quarters, washed in water, pricked with a stainless steel fork and soaked overnight in cold water. The pieces are then blanched and put in light sugar syrup. The strength of the syrup is gradually raised to 70° Brix (Khurdiya, 2001 b).

Pulp

The bael fruit pulp can be successfully extracted by adding water equal to the pulp (with seeds and fibre), adjusting the pH to 4.2 with citric acid (titratable acidity 0.5%) heating at 80°C for 1 minute and then passing through a pulping machine. Bael fruit pulp obtained by the standard method had almost the same consistency and colour as that of mango pulp.

Nectar

Various products can be prepared from Bael fruit pulp Bael fruit nectar is prepared by blending pulp with sugar, acid and water. A composition of 35% pulp, 25° Brix, and 0.3% acidity gives a highly acceptable product.

Squash

Bael fruit squash was found to be 50% pulp, 50° Brix and 1% acidity.

Slab

Bael fruit slab is prepared by adding 10% sugar with 1500 ppm and drying to a moisture level of 14.5%.

Toffee

Bael fruit toffee is prepared by mixing 40 parts of sugar, 4.5 parts of glucose, 10 parts of skimmed milk powder and 6 parts of hydrogenated fat to every 100 parts of Bael fruit pulp. The moisture content of Bael fruit toffee was found to be 8.5%.

Powder

Bael fruit powder is prepared by drying the pulp into sheets (2-10% moisture) after adding 2000ppm sodium carbonate. The sheets are then cut into pieces and further dried to a moisture level of 4%. The dried pieces are then ground into powder. Bael fruit powder can be mixed with an equal quantity of milk powder and reconstituted with water as required to make acceptable beverages.

Processing of passionfruit (*Passiflora edulis*)

The following products are processed from passionfruit.

Squash

Sugar syrup was prepared by adding cane sugar to boiling water. The strength of the sugar syrup was ascertained by testing with a hand refractometer. The solution is then filtered through muslin to remove the insoluble impurities. Fruit juice and hot syrup are added together in the proportion of proposed recipes on weight basis. The mixture is heated and the product treated with citric acid and potassium metabisulphite (300 ppm) to prevent spoilage. Later, the passionfruit juice is separately blended with pineapple and orange juice in equal proportion, by maintaining acidity (%) total soluble solids and juice (%) to the proposed recipe.

Nectar

The hot sugar syrup and juice are mixed on weight basis. The mixture is heated and the product treated with potassium metabisulphite to prevent spoilage. The prepared products are poured into pre-sterilised 200ml glass bottles immediately, which are sealed by using crown corks with the help of a leg-operated corking machine. The products are then sterilised in boiling water for 25-30 min.

Carambola (*Averrhoa carambola*)

Fruits are ready for harvesting in January-February and September-October

in South India. In North India, the fruits ripen in winter and spring. Mature fruits of carambola are harvested at the colour break stage. Carambola fruits can be stored for about 4-6 days under ordinary conditions. However, storage life can be prolonged under cold storage conditions. In a study conducted in Miami, carambola fruits of cv. Fwang and Arkin were packed in well ventilated cardboard cartons each containing 20 fruits and stored at 7.2°C for 4 weeks without having any adverse effect on quality (Khurdiya, 2001 a).

Tamarind (*Tamarindus indica*)

In South India, tamarind is commonly consumed in various culinary dishes or traditional drinks. Fruits contain about 30% pulp, 40% seeds and 30% hull. When fruits are ripe, pulp is rust-coloured and its water content is about 38%. Fruits (non-climacteric) must be harvested when ripe. Pulp is either sun-dried or mixed with sugar and stored for several months with no notable alteration in quality. Almost every part of the tree is used, especially for food preparation and for medicinal purposes. Traditional processing for food preparation is widespread, whereas its commercial uses as tamarind paste and powder are still relatively new in the country.

Jamun (*Syzygium cuminii*)

The importance of Jamun lies in its refreshing and curative properties. Jamun fruits can be processed into excellent quality fermented beverages such as vinegar or cider, and non-fermented Ready-To-Serve beverages and squashes. A good quality jelly can also be prepared from its fruits. The seeds can be processed into powder, which is very useful to cure diabetes (Khurdiya, 2001 b). Fully ripe fruits are harvested daily by hand picking or by shaking the branches and collecting the fruits on a polythene sheet. Jamun trees need a number of pickings, since all fruits do not ripen at a time. The yield of fully grown budded and seedling trees are 50-70 kg and 80-100 kg/plant/year. Jamun fruits are highly perishable. They can be stored only up to 2 days at ambient temperature. Pre-cooled fruits, packed in perforated polythene bags, can be stored for 3 weeks at 8-10°C and 85-90% humidity (Khurdiya, 2001 a). There is no standard practice for grading of fruit. Blemished or bruised fruits must be sorted out before packing. Fruits are normally packed in bamboo baskets and transported to local markets. In the market, fruits are sold on green leaves or on pieces of newspaper. The fruits pre-packaged in leaf cup covered with perforate polythene bags have little or no damage, during handling. Handling of fruits during transit from market to home is also easier in this container.

Extraction of juice

The fruits are washed in running cold water and passed through a grader. The crushed mass is heated to 60°C and passed through a basket press. By this way, a maximum yield of Jamun juice with high level of anthocyanins and other soluble constituents is obtained. The juice is heated to 85°C and cooled to room temperature, and then sodium benzoate (500 ppm) is mixed with juice and stored. Jamun juice can also be preserved by pasteurization. Jamun juice, being highly acidic, cannot be consumed as such. So an acceptable Ready-To-Serve beverage (nectar) is prepared with 25 per cent juice, 60° Brix and 0.6 per cent acidity.

Utilisation of pomace

Jamun pomace contains considerable amount of colours (anthocyanin), tannins and sugars. A method has been evolved by addition of 3:4 ratio of water to that of pomace to obtain pomace extract, which can be further, utilised in beverage industry. Pomace extract can be successfully utilised to supplement the pure juice for making beverage.

Custard apple (*Annona squamosa*)

Custard apple fruits are climatic; therefore, they are harvested when they are mature, firm and plump. The skin between the segments or tubercles turns into light yellow colour when the fruits are fully matured. The fruits are generally kept in straw for a few days until soft and are then consumed (Khurdiya, 2001a).

Pulp

Pulp is scooped out from ripe fruit and preserved with potassium metabisulphite. A recovery of 50% of pulp can be obtained from the ripe edible fruit. The custard apple pulp can be preserved with a minimum dose of 250 ppm of SO₂ in refrigerator but it required 500 ppm of SO₂ if it is to be stored at ambient temperature. In this way, it has a storage life of about 180 days. The custard apple pulp can be employed for making fruit drinks (Khurdiya, 2001 a). More than four thousand million bottles of aerated waters are produced in India, annually. The aerated water is coloured and flavoured by synthetic additives that may be potentially allergenic. It is a huge business in comparison with the fruit juice and beverages. If these aerated waters are fortified/substituted with some of the fruit juices it would prove a boon to the consumer as well as the grower.

Squash

Sugar syrup is prepared by adding cane sugar to the boiling water. The strength of the sugar syrup is tested by a hand refractometer (400-50°B range). The syrup is filtered through a muslin cloth to remove impurities. Fruit pulp and the freshly prepared hot syrup are added together in the proportion of proposed recipe on weight basis. The mixture is boiled by adding required amount of citric acid. Finally, the product is treated with potassium metabisulphite (300 ppm) to prevent spoilage. The prepared hot squash is poured into the pre sterilised 220 ml glass bottles. Immediately, bottles are sealed by using crown corks with the help of corking machine. Bottles are then sterilised in boiling water and cooled immediately, finally being stored at room temperature.

Nectar

Sugar syrup is prepared by adding cane sugar to boiling water. The strength of the syrup is determined with the help of hand refractometer. The prepared syrup is filtered through a muslin cloth to remove impurities. The hot syrup is mixed with fruit pulp on the weight basis. The mixture is boiled and citric acid added to get a consistent product. The prepared nectar is poured into the pre-sterilised 220 ml glass bottles and sealed airtight by using crown caps. The bottles are sterilised in boiling water for 25 minutes, cooled to room temperature and stored for further use.

Jam

Custard apple jam (pulp 45-50%, TSS 60-68 per cent) with a fixed level of acidity (0.5 per cent) is prepared. The required quantity of pulp, sugar as per the recipe is taken in a steel vessel and heated, stirring continuously. Separately, citric acid is dissolved in a little water and mixed with the pulp. Heating is continued until the required TSS is reached. Chemical preservative, potassium metabisulphite (0.1 g/kg) is mixed into the product after dissolving in little water. The product is poured into clean and sterilised jam bottles (500 g) and sealed hermetically (Chikkasubbana, Unpublished).

Karonda (Carissa carandus)

The fruits ripen from July to September in North India. In arid conditions, flowering starts late, and fruits ripen in the post monsoon period. Karonda requires 2-3 pickings. On an average, each plant provides 3-5 kg fruits. Both unripe and ripe fruits are harvested. There is no standard practice for grading and packing of fruits. Fruits after harvesting are kept in shade. Undesirable

or blemished fruits are sorted out. Good fruits packed in baskets are marketed. Storage life of fruits depends upon the stage of harvest. Fruits harvested at maturity can be stored for a week at room temperature and whereas fruits harvested at ripe stage are highly perishable and can be stored only for 2-3 days (Khurdiya 2001 a).

Pickles

The following recipe is used for Karonda pickle preparation. After the seeds are removed, 87% of the edible portion remains. The prepared fruits are kept in 2% salt solution to avoid browning. These are mixed with salt and kept for 24 hr. The cumin and fenugreek are roasted. The oil is heated and cooled. The fruits are mixed thoroughly with oil and all spices and then poured into glass jars and sealed airtight. The pickle was found in good condition up to eight months at ambient temperature (25-30°C) (Khurdiya, 2001 b).

Wood apple (*Feronia limonia*)

Fully developed immature fruits are harvested for preparation of chutney. Fully mature fruits are harvested for squash. Fruits are only eaten when they are fully ripe (Khurdiya 2001 a). Healthy fruits are graded into large and small sized fruits. Fruits can cope with ordinary conditions for 7-10 days.

Extraction of pulp

The wood apple fruits are opened by breaking them against a hard surface. The pulp, along with the seeds and fibre, are separated from the hard shell with the help of a stainless steel spoon. To extract the fine pulp without seeds and fibre, an equal amount of water by weight is added and boiled. The mass is passed through a muslin cloth to separate the seeds and fibre. The pulp thus obtained is homogenous. This fine pulp is used for the preparation of squash, nectar and jelly.

Squash

Sugar syrup is prepared by adding cane sugar to the boiling water. The strength of the sugar syrup is ascertained by testing (30-60°C Brix range). The syrup, thus prepared, is filtered through a muslin cloth to remove impurities. Fruit pulp and the freshly prepared hot syrup are added together in the proportion of the proposed recipe at a temperature of 90°C and poured into pre-sterilised dry glass jars. The filled jars are sealed and stored at room temperature for further use.

Nectar

Sugar syrup is prepared by adding cane sugar to the boiling water. The strength of the sugar syrup is estimated with the help of a hand refractometer. The prepared syrup is filtered through a muslin cloth to remove impurities. The hot syrup was mixed with the fruit pulp on the weight basis. The mixture is boiled and citric acid added to get a consistent product. The prepared nectar is poured into the pre-sterilised glass bottles of 220 ml capacity and sealed airtight by using crown caps. The bottles are sterilised in boiling water for 25 minutes, cooled to room temperature and utilised for further use.

Jelly

1 kg pulp is mixed in 1 litre of water in a container and homogenised with the help of a blender. The prepared pulp is boiled for 30 minutes stirring continuously. The hot boiling mass is passed through a muslin cloth and the extract is diluted to 1 litre. Then the calculated amount of sugar is added slowly to the pulp and boiled to a temperature of 103°C with the addition of citric acid, until the temperature reaches 107°C. The scum formed during boiling is removed with the help of ladle. Finally the prepared jelly is allowed to cool to a temperature of 90°C and poured into pre-sterilised glass jars. The filled jars are sealed and stored at room temperature for further use.

Phalsa (Grewia asiatica)

A fully grown phalsa shrub gives 5-6 kg fruits. Just after picking, the fruits are packed in well aerated bamboo baskets and sent to markets. Phalsa fruits are very perishable. They cannot be stored for more than 2-3 days under ordinary conditions. They can be graded according to size (large and small) and colour (turning stage and red ripe stage). Fruits (2-4 kg) should be packed in bamboo or mulberry baskets cushioned with gunny cloth or paper cuttings for distant markets (Khurdiya 2001 a). Corrugated cardboard boxes can also be used for packing.

Storage life of fruits depends on the stage of harvest. Fruits harvested at turning stage can be stored for 2-3 days at room temperature and about 7 days in cold store at 7°C. Fruits harvested at red ripe stage can be stored only for a day; hence, they are marketed immediately in local markets.

Juice

It is a deep crimson-red in colour with a pleasing flavour, which makes the

juice very popular. Fully ripe and sound fruits are crushed and mixed with two-third their weight of water in a blender. Then the crushed mass is heated quickly to 80°C, cooled, and finally passed through a muslin cloth to obtain a clear, crimson juice.

Phalsa Ready-To-Serve beverage (RTS)

A Ready-To-Serve (RTS) beverage from Phalsa fruit juice is formulated and standardised. It contains 25% juice and a Brix - acid of 45:1. The syrup is prepared from Phalsa fruit juice, the clear juice is mixed with an equal amount of sugar and preserved with sodium benzoate (Khurdiya 2001 b).

Ber (Zizyphus mauritiana)

Fruits do not ripen after picking. Overripe fruits lose their eating quality and storage life. Therefore fruits, which are just mature, and having a shining yellow colour should be harvested. The harvested ber should be sorted to discard the damaged, overripe, unripe and misshapen fruits. Then the fruits should be graded into groups of large, medium and small sizes. The storage life can be prolonged to 30-40 days by storing at 3°C and 85-90% humidity. Precooling of the fruits at 10°C immediately after harvest increases the shelf life by about 3 days when subsequently stored at room temperature. Preharvest spray of 1% calcium nitrate and dipping of the fruits before storage in 500 ppm Captaf also improves their shelf life (Khurdiya 2001a). Ber can be processed to prepare murabba, candy, dehydrated ber, pulp, jam and Ready-To-Serve beverage.

Dehydrated or dried Ber

Fully mature, slightly ripe and firm fruits, having a golden yellow to light chocolate brown colour, are selected for drying purposes. The fruit is blanched in boiling water for six minutes and rinsed in cold water. The blanched fruit is then exposed to sulphur dioxide fumes in a sulphur box by burning sulphur powder at the rate of 3.5-10 g/kg of fruits (depending on the size of the fruit) for 3 hours. The sulphured fruit is dehydrated in a cabinet drier at 60±5°C temperature to 20% moisture content. The fruit can also be dried in bright sunlight. Since there is more loss of sulphur dioxide, a heavy dose of sulphuring is needed when fruit is to be dried in the sun. The dried fruit is packed into 400 gauge food grade polyethylene bags and sealed airtight and allowed to stand at room temperature for 15-20 days in order to equilibrate the moisture content in it. The dried fruit is bulk-packed in biscuit tins under airtight conditions or retail packed in 300 gauge polyethylene pouches and then stored in tins. Katha and Umran varieties

have been found suitable for this purpose (Khurdiya, 2001 b).

Beverage from dried Ber

A Ready-To-Serve beverage (Khurdiya, 1980) containing 33.3% juice is prepared from dried ber (*Zizyphus mauritiana*) fruit after cooking and extracting the juice in a basket press. The juice has a pH of 3.75 and 19.6° Brix with 0.56% acidity. The ber juice is processed at 80°C for 10 mm. stored at room temperature (20-380°C). The beverage was organoleptically acceptable after storage duration of 9 months.

Canned Ber in sugar syrup

Fully mature and firm fruit should be selected for canning purpose. Peel is removed by hand with the help of a stainless steel knife by dipping in 5% boiling hot caustic soda solution for two minutes and then washed in running cold water followed by a second washing in water containing 0.1% citric acid in order to remove any traces of caustic soda solution. Then fruit is cut into slices with a stainless steel knife. The slices are packed with 40% sugar syrup containing 0.5% citric acid in a can in boiling water until the inside can temperature is raised to 800°C and sealed immediately. After this it is immersed in boiling water for 20 minutes and then cooled. These can be stored at room temperature for a year (Khurdiya 200 lb).

Candy

The Ber fruit is hard in texture, can be converted into murabba (glazed and crystallized fruit). The fruit is blanched in boiling water for six minutes and then rinsed in cold water. The peel is removed by hand with the help of a stainless steel tube (like a cork borer). The fruit is pierced with the help of a stainless steel pricker. The prepared fruit is kept in low concentration of sugar syrup (20-30% sugar syrup containing 0.5% citric acid) overnight. Next day, some sugar (250 gm sugar per 1 kg of prepared fruit) is added to the syrup and boiled for few minutes. This step is repeated several times and then it is allowed to stand for a week. Finally the syrup is heated to bring the concentration of sugar to 70%. If this is preserved as such, it is called murabba. Otherwise the syrup is drained and the fruit is dried in the open air for a few hours and then rolled over powdered sugar or sugar crystals in order to prepare crystallized fruit. If fruit is to be glazed then it is dipped into a 70% sugar syrup and dried. Then they are packed in airtight glass jars.

Pulp

Fully ripe, juicy varieties of ber are selected for pulp making. The seed is removed and the fruit is cut into small pieces. The fruit is heated with water (half to equal weight of the fruit) for a few minutes and passed through a stainless steel sieve. It serves as a base material for converting into beverages, etc. The ber pulp can be preserved by thermal processing or with chemical preservation. Squash from the ber pulp can be prepared by taking the following ingredients in a given proportion.

Pulp	1.0 kg
Sugar	1.7 kg
Citric acid	0.4 kg
Water	1.4 l.
Potassium metabisulphite	0.028 kg (2.8 g)

Sugar and citric acid are added to water and dissolved by heating. The sugar syrup is filtered and mixed with pulp after cooling. Then the potassium metabisulphite is mixed well with squash and filled immediately in already sterilised bottles leaving 2 inches headspace and sealed airtight.

Nectar

Sugar syrup is prepared by adding cane sugar to boiling water. The sugar ($^{\circ}$ Brix) content in syrup is tested using a hand refractometer. The syrup, thus prepared, is filtered through a muslin cloth to remove impurities. The extracted juice from fruits and freshly prepared hot syrup is mixed together as per recipes on weight basis. Required quantity of citric acid is added and finally potassium metabisulphite (0.1 g/kg) is added as a chemical preservative after being dissolved in a little quantity of the juice. The prepared nectar is poured into pre-sterilised glass bottles of 200 ml capacity and sealed with crown caps. The product is then processed in boiling water for 25 minutes, then cooled and stored at room temperature.

Squash

Sugar syrup is prepared by adding cane sugar to boiling water. The sugar ($^{\circ}$ Brix) content is determined with the help of a hand refractometer. The prepared syrup is filtered through a muslin cloth to remove impurities. The hot syrup and fruit juice are mixed on weight basis as outlined in recipes. The mixture is boiled by adding citric acid to get a consistent product and sodium potassium metabisulphite (0.1 g/kg) is added to prevent microbial spoilage. The prepared squash is poured into the pre sterilised 200 ml bottles and sealed with the help of a crown corking machine. Then the product is

processed in hot water for 25 minutes, cooled immediately and stored at room temperature for further observation.

Jam

Ber jam (pulp 45-50%, TSS 60-65%) with a fixed level of acidity (0.5%) is prepared. The required quantity of pulp and sugar was taken in a steel vessel and heated, stirring continuously. Citric acid is dissolved in a little water and mixed with the pulp. Heating is continued until the required TSS is reached. Chemical preservative potassium metabisulphite (0.1g per kg) is mixed into the product. The product is poured into clean and sterilised jam bottles (500g) and sealed hermetically.

PRESERVATION AND STORAGE OF BEVERAGES

Some of the detrimental factors that affect the preservation and quality of beverages are the presence of acids, time of sterilisation, and type of preservative and storage temperature. All these factors are complimentary in nature and add to the total success to extend shelf life and storage stability of fruit beverages. An ideal squash should have acidity of 1-1.5% whereas; in nectar it should be in the order of 0.3-0.5%. It is reported that acidity helps in the effective process, retention of colour, taste and flavour. Acidity also prevents development of unpleasant flavours or odours during the storage of the products (Chikkasubbana, Unpublished).

The most commonly used preservatives in fruit products are potassium metabisulphite and sodium benzoate. Sodium benzoate is normally preferred for the products which are rich in anthocyanin pigments such as Phalsa and Karonda, etc. Potassium metabisulphite is advocated for the products rich in carotenoids pigment.

PROCESSED PRODUCTS FROM UNDERUTILISED FRUITS

Jam

Aonla, Passionfruit (*Passiflora mollissima*), Barbados cherry, Bignay (*Antidesma bunius*), Bilimbi, Canistel, Cape gooseberry (*Physalis peruviana*), Capulin (*Prunus salicifolia*), Carambola, Cassabanana (*Sicana odorifera*), Cashew apple, Cattley guava, Ceylon gooseberry (*Dovyalis hebecarpa*), Feijoa, Gandaria (*Boaea macrophylla*), Jackfruit, Jamaica cherry (*Muntingia calabura*), Jarnun, Japanese persimmon, Karonda (*Carissa congesta*), Kei apple (*Dovyalis caffra*), Kiwi, Mamoncillo (*Melicocca bijuga*), Mulberry, Mysore raspberry, Natal plum (*Carissa*

grandiflora), Paniala, Pejibaye, Pulasan (*Nephelium mutabile*), Rose apple, Rambutan, Rukam, Santol, Marula, Seabuckthorn, Soursop, Surinam cherry (*Eugenia uniflora*), Sycomore fig, Tamarind, Wampee (*Clausena lansium*), Wood apple, Yellow mombin (*Spondias mombin*), Raspberry.

Jelly

Ambarella, Banana passionfruit, Barbados cherry, Bilimbi, Calomondin, Carambola, Cattley guava, Ceylon gooseberry, *Chrysophyllum albidum*, Citron, *Dialium guineense*, Feijoa, Imbu (*Spondias tuberosa*), *Irvingia gabonensis*, Jaboticaba, Jackfruit, Jarnun, Karonda, Kei apple, Kiwi, Kumquat, Malay apple, Mamoncillo, Mammee apple, Mysore raspberry, Naranjilla (*Solanum quitoense*), Purple mombin, Ramontchi (*Flacourtia*), Rose apple, Santol (*Sandoricum koetjape*), Marula, Seabuckthorn, Surinam cherry, Sycomore fig, Tamarind, Wampee, Wood apple, Yellow mombin, Cranberry (*Vaccinium macrocarpon*), American plum, Mountain cherry.

Preserve

Aonla, Bael, Banana passionfruit, Barbados cherry, Ber, Bilimbi, Breadfruit (seedless), Carambola, Cassabanana, *Crataegus pentagyna*, Ceriman (*Monstera deliciosa*), Feijoa, Jackfruit, Karonda, Lucuma, Mangosteen, Natal plum, Otaheite gooseberry (*Phyllanthus acidus*), Pummelo, Rambutan, Santol, Soursop, Cornelian cherry (*Cornus mas*).

Candy

Aonla, Breadfruit, Cashew apple, Indian fig, Ber, Karonda, Kumquat, Otaheite gooseberry, Palmyra palm (endosperm), Seabuckthorn.

Glazed fruit

Bilimbi, Carambola, Santol, Tamarind.

Confectionery

Amra (*Spondias pinnata*), Breadfruit, Marang (*Artocarpus odoratissimus*).

Juice

Calomondin, Cashew apple, Cupuassu, *Dialium guineense*, *Irvingia gabonensis* var. *gabonensis*, Mulberry, *Parinari curatellifolia*, *Parkia*

biglobosa, Passionfruit, Pomegranate, Soursop, Tamarind.

Syrup

Bael, Barbados cherry, Bignay, Calomondin, Carambola, Cashew apple, Ceylon gooseberry, Citron, Jaboticaba, Jarnun, Karonda, *Keora (Pandanus)*, Kumquat, Longan, Lucuma, Mulberry, Natal plum, Otaheite gooseberry, Paniala (*Flacourtia jangomas*), Phalsa (*Grewia subinoequalis*). Raspberry, Rose, Rose apple, Santol, Seabuckthorn, Soursop, Strawberry pear, Surinam cherry, Tamarind, Tangerine, White sapote (*Casimiroa edulis*), Wood apple.

Sherbet

Avocado, Bael, Bakuri, Cattley guava, *Keora (Pandanus)*, Naranjilla, Rose (hips), Tamarind, Raspberry.

Squash

Bael, Carambola, Jarnun, Mulberry, Passionfruit, Phalsa, Pummelo, Raspberry.

Beverages

Aonla, Bael, Ber, Black sapote (*Diospyros digyna*), Calomondin, Canistel, Capulin, Carob, Cashew apple, *Chaenomeles speciosa*, Cherimoya, Citron, *Cornus mas*, *Garcinia indica*, Jarnun, Nance (*Byrsonima crassifolia*), Phalsa, Pummelo, Purple mombin, Santol, Seabuckthorn, Soncoya (*Annona purpurea*), Soursop, Strawberry pear, Sweet calabash (*Passiflora maliformis*), *Terminalia chebula*, *Uapaca kirkiana* (masuku), West African ebony (*Diospyros mespiliformis*), Wood apple, Yellow mombin.

Wine

Barbados cherry, Ber, Bignay, Capulin, Cashew apple, Ceylon gooseberry, Cherimoya, Cupuassu, Feijoa, Indian fig, Jambolan, Karonda, Malay apple, Mamey sapote (*Pouteria sapota*), Nance, Palmyra palm, Pejibaye (*Bactris gasipaes*), Purple mombin, Rambai (*Baccaurea motleyana*), Seabuckthorn, Surinam cherry, Cornelian cherry.

Chutney

Ambarella, Aonla, Bilimbi, Gandaria, Karonda, Kiwi, Mango, Monkey jack, Otaheite gooseberry, Paniala, Rukam, Santol.

Sauce

Ambarella, Banana passionfruit, Calomondin, Cape gooseberry, Feijoa, Jamun, Karonda, Pomegranate, Tamarind, Cranberry.

Canning

Ber, Durian, Jackfruit, Litchi, Mangosteen, Palmyra palm (endosperm), Prickly pear, Rambutan.

Pickle

Breadfruit, Calomondin, *Carica chrysophylla*, Carambola, Gandaria, *Gonda* (*Cordia*), Jackfruit, Karonda, Kei apple, Ker (*Capparis decidua*), Malay apple, *Mangifera* spp., Monkey jack, Natal plum, Paniala, Purple mombin, Salak palm [unripe, fruit (*Salacca zoiacca*)].

Dehydration

Avocado, Bael, Ber, Custard apple, Indian fig, Jackfruit, Karonda.

Frozen puree

Barbados cherry, Custard apple and Sugar apple (*Annona* spp.), Tamarind.

Pies

Banana passionfruit, Cape gooseberry, Mamoncillo, Mysore raspberry.

Source: Ghosh, 2000 and Vijay Sethi, 1993.

CONCLUSION

Underutilised fruits are found only in a few local markets. Promoting these fruits has an advantage: they grow primarily under adverse conditions hence can be grown in various agro-climatic regions. Consumers today are increasingly conscious of health and nutrition, and there is a tendency to avoid chemicals and synthetic foods, thereby choosing natural foods. In this context, underutilised fruits have unlimited potential in their processed form. Strong campaigning for marketing is necessary to create awareness among the producers and consumers of underutilised fruits.

Appropriate process technology needs to be developed to popularise these fruits. Presently, some of these fruits are being traditionally used small scale: Aonla Chyavanprash, preserve, pickle; Karonda Pickle, jelly (mixed); *Tamarindus*- Puree, dehydration, sauce. Since most of these fruits have not yet been subjected to evaluation for various kinds of value added products, they cannot be subjected to mass production.

The marketing problem becomes more acute for underutilised fruits, which are qualitatively varied and quantitatively small. This has constrained the growth of new commodities. Appropriate marketing infrastructures with support from processing industry needs to be developed for the popularisation of underexploited fruit species. Therefore, exploitation of these species would require development of value added products after processing for table as well as medicinal uses.

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COUNTRY STATUS REPORT ON MARKETING AND PROCESSING OF UTF INDONESIA

Dr. M Winarno, Indonesia

INTRODUCTION

Underutilised tropical fruits such as jackfruit, mangosteen and pummelo, are widely known by the people in Indonesia.

Like other tropical fruit crops, they are grown and sold commercially throughout the country especially jackfruit.

PRESENT SITUATION OF CULTIVATION

Jackfruit and mangosteen are cultivated in almost all provinces, but not pummelo for which the cultivated area is still limited.

The fruit crops are usually grown at elevation of 100-1000 m, in the home-garden lots and in the dry land, and often mixed intercropping with other crops.

Most of the growers are smallholders. There has been little interest in developing commercial orchards.

Based on the statistical data of 2000, the total number of jackfruit cultivated trees was higher than mangosteen and pummelo (Table 1).

Table 1 Cultivated trees/area and production.

No.	Fruit Crop	Cultivated Trees/area	Production (000 ton)	Leading varieties
1.	Jackfruit	4,000,000 trees (± 40,000 Ha)	300	Kunir, Pasir Pangarayan
2.	Mangosteen	5,000 Ha	26	Kaligesing
3.	Pummelo	600 Ha	17	Nambangan, Magetan, Cikoneng, Bali Merah

Note: Three main provinces: East Java, West Java, and Bali

The trees are mostly grown from seeds. Vegetatively propagated plants are very rare, especially for jackfruit and mangosteen.

Tree spacing is irregular and there has generally been no intensive crop management as applied in a commercial orchard. It seems that the growers let the trees grow naturally.

MARKETING

Most of the production is for the domestic markets, except some quantities of mangosteen are exported to Taiwan, European countries, and the Middle-Eastern countries. The main harvest season is October-February for mangosteen and June-September for pummelo. Jackfruit is harvested year-round.

In some production areas, pre-harvest contractors go to the village and negotiate with the tree owners and buy the fruits when they are still immature on the trees (Indonesia: *ijon* system). When the contractors and growers have reached a consensus on price, then growers received in advance payment about 50 – 100% of the total price. In the last harvest season the farm gate price was US\$ 1 for a 10 kg jackfruit, US\$ 0.5/kg of mangosteen, and US\$ 0.5/fruit of pummelo.

Once the growers receive the payment, the responsibilities are shifted from the growers to the contractors. The contractors will decide the harvest time. Generally, they will harvest when the price is high. Maturity standard becomes a secondary factor in deciding the harvest time. Therefore the quality of the fruit may not be the best. Once fruits are harvested, they are transported and sold to the retailers or to the commissioning agents for export. Jackfruit is generally transported without any packaging, in bulk, in the trucks. Mangosteen and pummelo are packed in bamboo baskets, wooden crates, or rigid plastic containers.

Besides the pre-harvest contractors, growers also sell fruits to the village traders and also directly to the local markets. The trade flow is illustrated in Figure 1.

PROCESSING

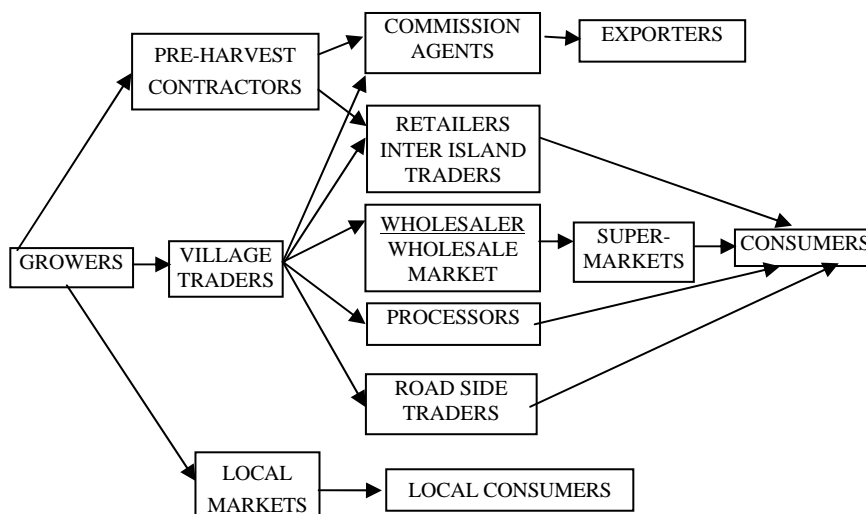
Jackfruit is consumed both fresh and processed, but not the mangosteen and pummelo which are rarely processed.

The pulp of young jackfruit can be cooked as a vegetable.

Jackfruit chips are becoming more popular in the market. They are produced mostly by home industries. Jackfruit chips are prepared by slicing and drying in a controlled temperature and humidity oven. The ratio is about 10 kg of

fresh jackfruit to 1 kg of jackfruit chips. The chips are packed in a plastic bag or carton and marketed locally or exported.

Figure 1 The Trade Flow



Jackfruit can also be processed into:

1. “Dodol”: cooking a mixture of glutinous rice flour, brown sugar, and jackfruit pulp
2. Jams and juice.

Jackfruit seeds can also be dried and salted as nuts.

In certain provinces, the peel of pummelo is processed into candy or sweet and sold commercially.

Processing of mangosteen is very rare, but the pulp is occasionally used as a mixture of cake and the rind may be processed into dye.

CONCLUSION

The role of middlemen or village traders is significant in assisting growers to market their produce.

Processing of underutilised tropical fruit crops may increase their economical value.

STATUS REPORT OF PROCESSING AND MARKETING OF UNDERUTILISED FRUITS IN NEPAL

Dr. Deva Bhakta Shakya, Agro Enterprise Centre, Nepal

INTRODUCTION

Nepalese agrarian economy is based on complex farming systems where crop cultivation, livestock raising and utilisation of forest resources are closely interlinked. Agriculture is the main source of livelihood for the majority of 23.2m population of Nepal. About 80% of the rural population aged 15+ years is engaged in agriculture and 88% of the population live in rural areas. In 1999/2000, agriculture provided almost 39% of total GDP. The GDP in the agriculture sector is lower at less than US\$ 140 per agricultural worker.

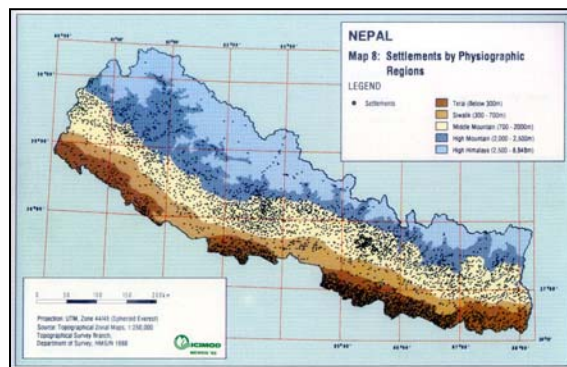


Figure 1 Settlements by Physiographic Region

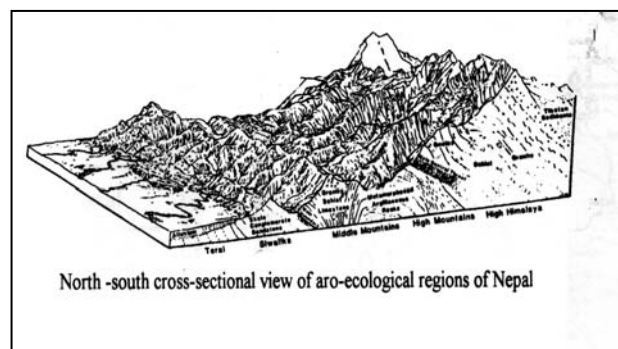


Figure 2 Cross-sectional view

In 1996, about 40% of agricultural households with land had less than 0.5 ha, implying that a considerable part of the agricultural population had serious problems in sustaining its livelihood from agriculture. In the mean time, poverty in Nepal is pervasive with about 42% of the population living below the poverty line. A large part of the poor are the hard-core poor barely eking out a subsistence level of fragile, vulnerable ecosystems in a large area of the country without even the most basic infrastructures. Poverty is much more severe in rural areas compared to the urban areas.

Taking note of the above facts and figures, any attempt to increase the income of the rural population (through improved farming practices to increase productivity and quality) off-farm activities (like best utilisation of forest resources without disturbing the natural eco-system) and some value-addition activities based on these will be of much help in the process of poverty reduction. An attempt is made here to examine the current scenario of fruit production in general and underutilised fruits in particular and also the value addition prospects of potential native and wild fruits, such that some economic activities could be carried out at the rural level, thereby creating employment and the additional income generation.

FRUITS PRODUCTION IN NEPAL

Fruit farming in Nepal is widely distributed to different agro-ecological regions as Nepal has an advantage of favourable climates and different topographical conditions unique in the world. It has cool temperate zone, warm temperate zone, sub-tropical zone and tropical zones.

As such, it has more than 55 species of different fruits, grown commercially/ homestead and wild in Nepal. Out of these, only a few fruits are found grown in commercial scale. These include: apple, banana, guava, pears, peaches, lime, lychee, mandarin, mango, papaya, pineapple, and sweet orange (Junar), etc. The total productive area used for fruit production is estimated at 46,492 ha and the total production has reached about 447,334 MT. Out of the total production 25% accounts for citrus type of fruits and almost 30% of the total fruit area is covered by summer fruits. Details are given in Table 1.

Table 1 Production of major fruits in Nepal: 1999/2000

Fruit	Type	Productive Production area estimate (Ha.)	Production estimate (MT)	
Citrus	All	11277	115067	
	Orange	6588	70824	
	Sweet Orange	2311	26337	
	Lime	1867	14072	
	Lemon	401	2993	
	Others	110	841	
	Winter	All	10169	87252
Winter	Apple	3278	31197	
	Pear	2550	29256	
	Walnut	976	3783	
	Peach	1879	12886	
	Plum	1252	8790	
	Apricot	82	560	
	Persimmon	53	358	
	Pomegranate	90	411	
	Almond	11	11	
	Summer	All	25046	245015
	Summer	Mango	12223	90976
Banana		3401	48005	
Guava		3138	36115	
Papaya		2054	28892	
Jackfruit		13920	16169	
Pineapple		701	9980	
Litchi		1870	14387	
Areca nut		98	146	
Coconut		170	345	
All fruits	Grand Total	46492	447334	

CONTRIBUTION OF FRUITS IN THE NATIONAL ECONOMY

The contribution of fruits in the national economy of Nepal is very small as the production area covered by fruit is only 1.7% of the total agricultural land utilised in Nepal. The total quantity produced and the average yield of fruits is also relatively lower. But this is one of the economically important crops after cereals, pulses, oilseed and vegetables. The annual return from fruit farming is much better than that of cereal grains, oilseeds and pulses. Although wide varieties of fruits are grown in this small country, much of the fruits grown particularly in mid hills, high hills and mountain regions are having market accessibility problems. Hence, farmers with good access to roads have been

able to get a very good income from the fruit farming while farmers in the remote areas have not been able to get similar economic returns.

IMPORT AND EXPORT OF FRUITS AND FRUIT PRODUCTS

As fruits produced within Nepal are not accessible to the urban area where needed, almost 30-40% of the demand of the urban population of 33m (average per capita consumption of 22.8 kg/yr) is still met through imports of fresh fruits and semi-processed/processed products from India, China and many other countries (Table 2). From India, major fruits imported are Banana, Apple, Sweet Orange, Pomegranate, Orange, Grapes, Mango etc. Due to the open border, it is difficult to establish actual quantities imported. The amount of import is far more than the figure available through statistical records.

On the export front, every year a small quantity of orange (tangerine), pears and sweet oranges (Junar) comes across the Indian border and watermelon, mango and oranges are exported to Tibet (autonomous region of China); statistics are unavailable. Export of processed fruit products is insignificant.

Table 2 Fruit and Fruit Products Imported from Overseas and India 2000/2001

Product	Value in Rs. (Million)	Countries from where fruits are imported
Edible fruits and nuts from overseas	1177	(Thailand, Singapore and Indonesia)
Prepared/Preserved Olive	.322	China, Spain, Thailand, HK, ROKorea, Malaysia,
Sugar preserves	0.593	Singapore, Argentina, USA,
Jam/jellies	2.744	<u>Australia</u> UK, Germany,
Fruit juices	10.35	<u>Brazil</u> , Thailand,
Fruit pulp	1.167	Philippines, <u>South Africa</u> ,
Fresh fruits from India	81	<u>Netherlands</u> , Bangladesh
Total import	1273.2	and Vietnam

UNDERUTILISED FRUITS OF NEPAL

For the sake of simplicity the term "underutilised fruits" is considered in this paper as the fruits that are native/grown locally, but underutilised in Nepal and that are harvested from the wild.

There are 45 species belonging to 37 genera reported to be available as edible wild fruits in Nepal. A list of some of the important ones in the category of underutilised fruits in Nepal is presented in Table 3.

Table 3 List of Underutilised (Native/Wild) Fruits of Nepal

Name in Nepali	Scientific Name	Region Where Grown	Use	Fruiting Time
Ainselu (Black Raspberry)	<i>R. foliolosus</i> . Don	700-2000m	Fresh, Wine	May-Jun
Ainselu (Yellow Raspberry)	<i>Rhubus ellipticus</i>	Mid Hills 700-2000m	Fresh, Wine	May-Jun
Ainselu Rato (Ceylone Raspberry)	<i>Rosaceae acuminatussm</i>	700-2000m	Fresh, Sharbat	May-Jun
Amba (Guava)	<i>Psiudium guajava</i>	Terai And Mid-Hills <1200m	Jam/Jelly, Candies	
Amla (Aonla or Indian Gooseberry)	<i>Emblica officinalis or Phyllanthus emblica</i>	Churia Forest <1400m	Murraba, Sauces, Pickles/ Chutney, Chyawanprash, hair oil	Dec-Mar
Aru (Peach)	<i>Prunuis persica</i>	Mid Hills to High Hills	Fresh, Dried	Sep-Oct
Asian Pear (Sand Pear)	<i>Pyrus pyrifolia</i>		Jam/Juice and Wine	Jul-Oct
Bael Bengal Quince	<i>Aegle marmelos</i> (L.) <i>Correa</i>	Terai to Lower Hills	Laxative, Squash richest Source of Riboflavin, Sarbat	May-Jun
Ber (Chinese Date or Wood Apple)	<i>Ziziphus jujuba</i>	Terai to Mid Hills <1000m	Fresh	Dec-Jan
Bhogatee (pummelo)	<i>Citrus grandis</i>	Sub tropical	Fresh	
Bimero (Citron)	<i>C. medica</i> L.	Mid Hills	Fresh	Sep-Dec
Chaksi (Sweet Lime)	<i>Citrus limettioides Tanaka</i>	Mid hills	Fresh, Juice, Fragrance	Oct-Dec
Cheuri (Indian Butter)	<i>Bassia butyracea or Aesandra butyracea Roxb</i>	Innner Terai to Mid Hills 600-1500m	Vegetable Fat	Jun-Aug
Chutro (Nepal Barberry)	<i>Berberis aristaca</i>	1900-2400 M	Wine	May-Jun

Name in Nepali	Scientific Name	Region Where Grown	Use	Fruiting Time
Dale Chuk (Seabuckthorn)	<i>Hippophae salicifolia Tibetana</i>	2000m-3700m>4000mmugu, Musatang, Humla, Dolpa, Manang, Jumla, Jajarkot Darchula	Squash, Jam, Wine and Concentrate, granules, cough syrup	Jul-Sep
Emli	<i>Tamarindus indica L</i>	Terrai to Lower Hills	Souring Agent/Ingredient	Apr-Jun
Haluwabed (Persimmon)	<i>Diospyros virginiana</i>	Temperate/Subtropical 1200-1500m	Dried Products	Sept-Oct
Jamun (Java Plum or Black Plum)	<i>Eugenia jambolana Lam. Syzygium cumunii (L) Skeels</i>	Terai to Lower Hills	Jam/Jelly, Squash, Juice/Wine, Pickles	Jun-Aug
Kafal (Bay Berry or Box Myrtle)	<i>Myrica eculanta</i>	Hilly Regions Ranging From 1200-2000m	Fresh, Sarbat, Tanning/Dyeing	May-Jun
Kali Jyamir or Kathe Jyamir (Rough Lemon)	<i>Citrus Junos Tanaka</i>		Juice, Chuk (Concentrate)	Oct-Dec
Kimbu (Mulberry Black)	<i>Morus alba</i>	Mid Hills		Apr-Jun
Katush (Nepali Chestnut)	<i>Castonopsis indica</i>	Mid Hills 450-2500m	Dry Nuts	Aug-Nov
Khurpani (Apricot)	<i>Prunus armanica Linn.</i>	High hills	Fresh, dried and Jam	Jul-Aug.
Lapsi (Mombin Like)	<i>Choerospondias axillaris</i>	High Hills of Central Nepal	Candy, Pickles, Fruit Leather, Dry Powder	Sept-Dec
Mayal (Wild Pear)	<i>Pyrus pashia</i>	700-2000m	Alcohol Beverage	Nov-Dec
Okhar (Walnut)	<i>Juglans regia</i>	Temperate Region	Dry Nut	May-Nov
Ram Phal (Custard Apple)	<i>A.reticulata</i>	Terai to Lower Hills	Fresh	Aug-Sep
Rokh Katahar (Jackfruit)	<i>Artocarpus heterophyllus</i>	Terai to Mid Hills	Pulp Used for Preserve	Dec-July
Sati Bayar (Nepal Sumac)	<i>Rhus parviflora</i>	Foot Hills	Dry	Dec-Apr

STATUS OF FRUIT PROCESSING INDUSTRIES IN NEPAL

Almost all fruit processing industries in Nepal are limited to production of conventional products, such as pickles, squash, jam/jelly/marmalades and candies. Some fruit growers in remote districts of Mustang and Jumla have been drying apples and apricots. Of all the underutilised fruits mentioned in the list above, only Lapsi and Amla have been utilised very widely in Kathmandu Valley and neighbouring districts for extraction of its pulp and preparation of dried fruit leather and candies. Some fruits like Jamun, Persimmon, minor citrus fruits and berries have also been utilised in very small quantities for processing into juices, concentrates, dry products, etc. by small and cottage industries. Some of the known fruit processing industries are listed in Table 4.

Most of these industries are basically processing commercially grown fruits like orange, mango, apple, pineapple, guava, lemon, pears, sweet orange, papaya etc. and no industry is apparently involved in processing any of the native/ wildly grown species, except for the production of wine based on wild fruits like chutro, ainselo etc. and of lapsi and amala-based products.

Table 4 List of Fruit Processing Industries in Nepal

Scale	Name of Industry	Address	Products
Medium	Rijal Tashi Industries	Ithari/Sunsari	Juice, Jam/Jelly, Pickles, Canned products
	Dabur Nepal Pvt. Ltd	Tokani/Bara	Fruit juice & drinks, Ayurvedic products (eg chyawanprash, hair oil)
Small	Dugad Food and Beverages Pvt. Ltd	Satungal/Kathmandu	Fruit drinks
	Gold Beverage Nepal	Bhaisepati, Kathmandu	Fruit drinks
	Alpine Food industries	Koteswor/Kathmandu	Fruit based drinks, dehydrated fruits
	Himalayan Natural Fruits Industries	Sanga/Kavre	Lapsi candies, Lapsi Leathers, Pickles
	Nepal Phal Udyog	Chovar/Kathmandu	Fruit wine
	Nebula Fruit Products	Tahachal/Kathmandu	Fruit Squash
	Butterfly Canning Company	Battisputali	Juice, Jam/jelly/marmalade and processed fruits
	Fresh Fruits Industries	Swoyambhu/Kathmandu	Mango, lapsi, pineapple candies
	Katoo	Rajbiraj/Saptari	Squash/juice, pickles
	Makalu Wine Industries	Tamafok/Sankhuwasabha	Fruit wines
Cottage	Pragatee Woman Multipurpose Cooperative	Nawalparasi	Papaya jam/candy
	Thankot Organic Farm	Thankot, Kathmandu	Jam/Jelly, dry fruits, wine
	Everest Vegetables and Fruit Products	Naxal/Kathmandu	Sauce, fruit juice
	Himalayan Harvest	Maharajgunj/Kathmandu	Dry Mango
	Narayan Juice Udyog	Ichangu/Kathmandu	Orange juices
	WEAN Cooperatives	Lalitpur	Pickles/candies/dried fruits
	Prabhat Gharelu Squash Udhog	Okhreni/Ramechap	Junar squash
	Many Industries	Kavre	Lapsi Candies
	Many Distillaries	Mustang/Kathmandu	Alcoholic products

MARKETING OF UNDERUTILISED FRUITS

Most of the underutilised fruits listed are wildly grown and collected during the season and either used locally or brought in small quantities to the local markets like hat bazaar for casual sale. In many cases, the bulk of the produce is kept for drying or preparation of juice concentrate and sale during cultural and religious festivity seasons. Current marketing practices indicate that only a few fruits like guava, jackfruit, lapsi, pummelo, and persimmon get into the wholesale market in bulk before going for retailing in the urban areas. There is no set pattern of pricing and weight and measure. Many items like kimbu, kafal, ber, amla, ainselu, katush etc. are sold by volume and not available for bulk sales. Price history for most of these fruits is not available, as the pricing trend is individual, inconsistent and season dependent. Some fruits like bael, citron, kali jyamir and sweet limes are found in the market only during the Tihar festival (festival of light). Some fruits like Cheuri hardly enter the market, as the fruit is valued exclusively for the extraction of fat from the seed.

The quantities of fruits traded are of very low volume even when considered in bulk. The actual transaction of two main underutilised fruits (lapsi and jackfruit) that has taken place in the only wholesale market of the capital city of Nepal is presented as examples in Table 5.

Table 5 Marketing and Current Uses of Underutilised Fruits Kalimati Sales: 2057 (2000/2001)

Fruit	Quantity Transacted	Source	Season	Price
Lapsi	520.3 MT	KTM: 320 MT Dhading: 199.4MT	July to April (October to November Max.)	Rs. 9 to 64/kg. Highest in April
Jackfruit	679 MT	SarlahiBara, Chitwan, Parsa, Nawalparasi, Rauthat, Sunsari, Jhapa etc.	January to July (April to June Max).	Rs. 10 to 30/kg. July Least, January Highest

CURRENT EFFORTS IN THE DEVELOPMENT AND UTILISATION OF NATIVE/WILD FRUITS

Many NGOs/institutions have made several efforts in the past to promote some of the underutilised fruits for commercial production and value-addition. Major institutions involved in promotion of underutilised fruits for the economic uplifting of the rural population are given in Table 6.

Table 6 Institutions Involved in Underutilised Fruits Promotion

Name of the Institution	Fruits of Interest	Type of Involvement
Green Energy Mission Nepal	Bel	Promotion and Expansion on its use
Intermediate Technology Development Group (ITDG)	Lapsi, Chiuri	Promotion
Department of Food Technology and Quality Control	Lapsi, Bel, Chutro, Amala, Persimmon etc.	Training, Information, and Specification development
Singhdurbar Vaidyakhana	Amala, Chutro	Ayurvedic Preparation
Department of Forestry, HMG, Nepal	Wild Fruits	Identification, and conservation
RECAST	Lapsi, Seabuckthron, Amala, Cheuri etc	Research
ICIMOD	Seabuckthron	Promotional
Sea Cow	Chiuri, Amala	Research and Processing
Gorkha Ayurved Company	Amala	Processing
MEDP	Lapsi	Promotional
Dept of Natural Resources/Ministry of Forestry/Godavari	Lapsi, Amla	Research
Ministry of Agriculture, Horticulture Development Division	Pommelo, Guava, Persimmon, Lapsi etc.	Germ Plasm collection and maintenance, varietal trials and orchard management extension

SOME OF THE IMPORTANT UNDERUTILISED FRUITS IN NEPAL

Amala (Emblica officinale)

It is a native fruit growing in the region of upper terai to mid hills (900-1400 msl) of Nepal. Up until now it is mainly utilised for masticatory purposes. Other uses are for making candies and pickles, and dried fruit (Bari). To some extent it is used in making the herbal medicines: mainly hair conditioners and anti-constipatory preparations.

The native fruit is growing in the jungles and is derived mainly from the wild varieties. However, there is an increasing trend of cultivation of this tree in households, but not commercially as in our neighbouring country India. The native or jungle variety found in Nepal is smaller in size and has less flesh content and high seed content. But according to a survey carried out, there lies no significant difference in Vitamin C content between improved (cultivated) varieties and the wild one.

Table 7 Proximate Composition of Vitamin C

	Cultivated Variety	Wild Variety
Flesh (%)	90.31	84.2
Seed (%)	9.68	15.65
Average Size (cm)	2.5	2.0
TSS of Juice (0Bx)	13	12
Moisture (%)	80.59	78.83
Crude Fibre (%)	3.16	3.11
Ash (%)	0.72	0.74
L-ascorbic acid (Mg/100g)	405.6	421.0

Figure 3 Dry Amala

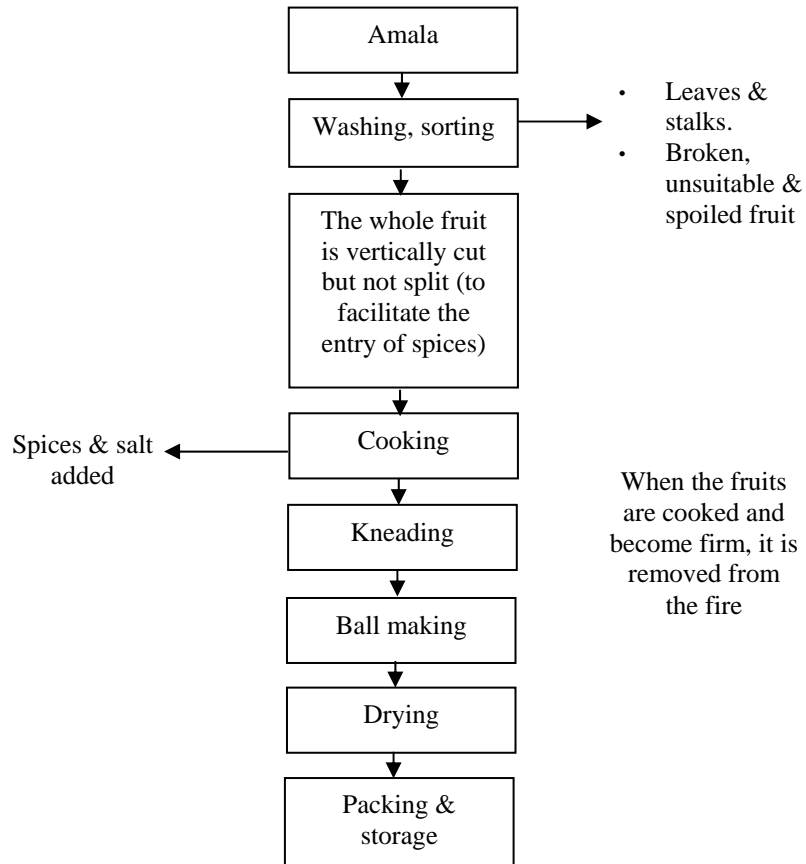
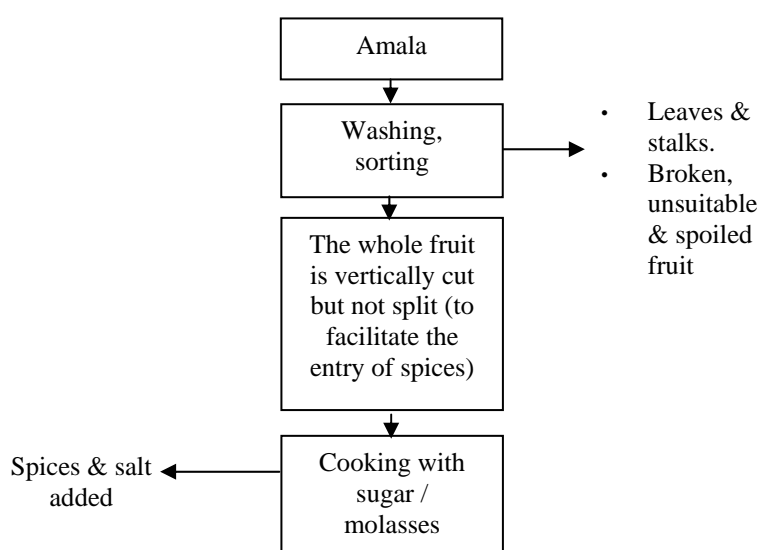


Figure 4 Indigenous Method of Processing Amala: Pickle



Lapsi

It is a large melia-looking deciduous tree found around the Kathmandu valley and adjacent areas and in the pockets with similar eco-zones. It is considered a very unique fruit of the region. The fruit is a fleshy drupe, which is olive green when unripe and greenish yellow at full maturity. The average size of the fruit is around 2 to 3 cm diameter. The size of stone is almost half of the whole fruit. The fleshy and pectineous pulp of ripe fruits is used in preparing pickles, candies, fruit leather, relish and Titaura etc. It is very popular in Nepal and is in high demand in the domestic market. Fruits are harvested in September-December.

It is usually consumed either as fresh for the preparation of chutney and pickles. The pulp is manually extracted from the fruit by boiling, peeling and removing stones and is mostly used for the preparation of preserves, relish, dry candies and fruit leather by adding sugar and/or salt. Dry candies and leather is very popular amongst the youngsters as well as the adults and is also becoming an item of gift for foreign visitors. The peel of the fruit is also used widely and commercially as the souring agent while preparing traditional dishes.

Lapsi is also believed to be a good source of ascorbic acid (Vitamin C). The pulp and peel both contain a relatively high content of ascorbic acid ranging between 50 to 100 mg per 100 gm pulp or fresh peel.

The lapsi tree starts bearing fruit after six years, and at the age of about eight each tree gives around 200 to 250 kg fruit. The yield increases as the age of the plant increases. However, the life of the plant is around 35 to 40 years.

This is one of the underutilised fruits that has been considered for promotion by HMG of Nepal. After successful trials of grafting and plantation of quick-yielding lapsi trees, the lapsi stocks are being distributed each year by one of the horticulture farms at Godavari/Kathmandu and more than 30 ha have been covered within the vicinity of Kathmandu Valley and nearby districts. It is expected that there will be more than 100 ha plantation by the end of this fiscal year.

Within the last two decades, more than 10 cottage industries have emerged just to manufacture products based on lapsi as the economic and nutritional value of the fruit was realised. Demand for the fruit is ever increasing as the products started slowly diversified and the external market is also visible. However, the scale of production is still limited because of the non-availability of fruits, consistently and in sufficient quantity.

Pummelo

In Nepal, pummelo has been grown for centuries in homestead gardens for domestic production and religious and cultural uses as temple fruits. Its demand has been increasing mainly in warm areas. It has been mostly cultivated in the subtropical fertile valleys/river basins and mid hills. Nepal is believed to have highest diversity of pummelo among South Asian countries.

The tree starts fruiting at different time periods, in the mid-hills from December to February and in the Terai plain land from September to January. The study made by the DFID/ICUC project in Nepal to assess the diversity revealed in 1999 that this fruit in Nepal is oblate, spheroid, pin form and ellipsoids in shape and trees bear from 30 to 500 fruits per tree and the weight of a single fruit was also found to vary between 400g-2.34 Kg.

Table 8 Physico-Chemical Parameters Useful for Processing Pummelo

Physico-Chemical Characteristic	Range
No. of Segments/fruit:	407-2355
No. of seeds/fruit	2-173
Pulp colour	White, creamy to dark red
Pulp % by weight:	21-63.8
Juices % by weight of pulp	40-79.4
Total Soluble solid in juice (TSS):	6.4-12.8
% Acidity of juice (TA):	0.67 – 3.3
TSS/TA Ratio	1.9-14.2

The juicy pulp of pummelo is mainly consumed as fresh and also for the preparation of tasty juices. The fruit is believed to be rich in sugar, Vitamin A, B1, B2, B12 and C. The flowers and fruits are occasionally used for medicinal purposes/fragrances; the skin can be used for pectin extraction. No attempt to derive processed products from this fruit has been reported so far.

Cheuri

Cheuri (*Bassia butyracea*/*Madhuca butyracea*) is a native fruit of Nepal grown in the sub-himalayan tracts on steep slopes/cliffs at an altitude of 400-1400 m. Its tree is medium-sized and is an economically important crop for some tribal/poor farmers, economically sustainable, soil maker and adapted to uncultivated land.



Figure 5 Cheuri

The cheuri trees are wildy grown and it was estimated that there were about 0.6m trees and only about 0.45 million of the trees were accessible with an average yield of 25 kg dry seeds/tree. The annual total seed and cheuri ghee production in 1995 was estimated at 1825 MT and 640 MT respectively. The price of seeds, if sold, remained within Rs 5-13/kg.

The fruit is currently principally used for the utilisation of the seed to produce vegetable fat called "Cheuri ghee", which tends to be the main edible fat source for the tribal communities (~ 100,000 population) where it is grown. The dry seed, which constitutes 11-15% of the weight of fresh fruit, contains 50-70% oil, which at normal temperature remains in solid state. Major constituent fatty acid is palmitic acid and oleic acid. Average yield of fat by traditional and improved technologies were reported to be around 38% and 45% of the weight of the seed, respectively and the price fetched at the road head by the communities for cheuri ghee are 35-45 Rs/Kg.



Figure 6 Chepuwa

The ghee is currently prepared by extracting seed using local technology using "Chepuwa" a two plank device pressing in a bamboo basket filled with crushed and steamed seed flour. A new technique with powered screw expeller is also being used in some parts where Cheuri is available in economic scale, particularly in Arghakhanchi.

Because of the high saponin content (about 10% of fat), it is not used commercially for edible purposes in the urban areas but is being used for butter lamps during worship. It is being used as one of the ingredients in soap manufacturing.

The pulp of Cheuri fruits (~50% of the weight of fresh fruit) is taken as food by the tribal communities and brought to market in small quantities for sale. The community is taking it as a source of food during food scarcity. The pulps contain about 6.5 % total sugar with the proportion of reducing and non-reducing sugar at 50:50 basis. It is also a fairly good source of crude

fibre (6%), pectin (0.29%) and vita C (3.21 %). However, as collection of fruit is primarily for seed, a large quantity of pulp, coming out during seed collection, could not be consumed by the communities at the time of ripening/harvesting season and sales of fruit in the market will deprive them from collecting the seed and producing ghee.

An effort was made to value addition to Cheuri fruit by introducing Cheuri squash by the ol of Ecology, Agriculture and Community Works (SEACOW). Trial production was made and the product was introduced in the market in the Band of "RASILO". However, the poor sanitary conditions of preparation and the inadequate processing have created a problem of poor shelf life of the product. It could not be continued in the market as expected. If the product's shelf life could be enhanced and product quality & packaging could be improved, this type of product could be a tool for empowering the tribal community through better off-farm activities and income.

Seabuckthorn

It is a deciduous shrub (*Hippophae Linn.*) belonging the family of Elaeagnaceae and found widely distributed throughout the temperate areas of Asia up to 5,200m as it can resist low temperature as low as -43°C. It has a highly developed root system hence is an excellent biotic choice for holding the soil on a fragile slopes/marginal lands.

The shrub is reported to yield between 500-750 kg of berries/ha. The fruit is small, and orange-coloured and is rich in carbohydrates, organic acids and amino acids, a very good source of Vitamins C, E, K and A and essential elements like Ca, Al, Fe and Mg. The seed content of the fruit varies from 11-22%. Its pulp and seeds contain high quality oil (high proportion of unsaturated fatty acids ~85%) having therapeutic value. It has been used in at least a dozen countries as traditional medicine. It is also being used in food industries (fresh juice, soft drink, drink granules, wine/champagne, Jam, candies, shampoo, cough syrup etc), medical industries, in cosmetic preparations etc. It is gaining much popularity in China.

In Nepal, this fruit is wildy grown in Mugu, Dolpa, Humla and Manang districts, which are very remote and rain-shade areas, all having the characteristics of Tibetan plateaux. Some study teams examined the physico-chemical quality parameters of the fruit grown in Nepal and some relevant data for processing are presented in Table 7.

Initial exploratory activities on Seabuckthorn in Nepal was carried out by ICIMOD in Mustang region and later on the promotional/developmental activities were continued by the Ministry of Local Development with the support from the Tree Improvement Programme of Ministry of Forest

Resources and DANIDA. Trial production of squash, jam and wine (mixed together with grape) was carried out and currently the squashes are seen in the market as a health drink. In the remote areas the fruit is also used for the production of juice concentrate using the traditional technique of boiling. Trial extraction of oil from the seed has also been carried out. However, the commercial production of oil is yet to be seen.



Figure 7 Seabuckthorn

Table 7 Typical Physical and Chemical Parameters of Seabuckthorn

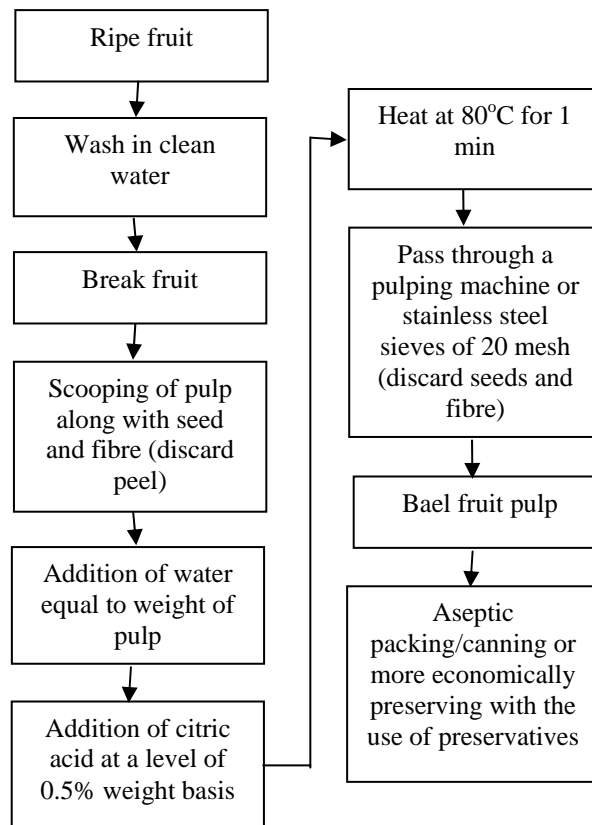
	Fruit wt/100 pieces (gm)	Juice% of the fruit	TSS of Juice o Brix	Total sugar content of Juice%	Vitamin C content of Juice mg/100gm	B- carotenemg/1 00gm	Oil content%	Organic Acid%
Fruit	10.8-16	69-76	10	6.29	741	7.3	2.2	4.35
Pulp				7.17	780	7.7	2.05	4.4
Seed				5.84	149	3.3	8.36	0.94

Bael

Nepal is very rich in wild Bael fruit tree populations and it spreads throughout Nepal in the sub-tropical region covering the terai plain land and the mid hills, as one of the non-timber forest products. Its religious and cultural values have been very much recognised in Nepal in the traditional manner but its economic values have not been exploited yet on a commercial basis.

Bael is also considered as having medicinal value for curing different diseases including cholera and diarrhoea when used at the half-ripe stage and is also considered a tonic for heart and brain. It is believed to show some anti-viral activity against virus diseases and anti-helminthes. It is also considered to be one of the most nutritious fruits as it is claimed to contain the highest riboflavin amongst all fruits and it is also as rich in Vitamin C as the sweet orange.

Figure 8 Flow Chart of Bael Pulp Extraction from the Fresh Ripe Fruit



Price of Bael Fruit

Bael fruit juice is often made at home from the ripe fresh fruit during summer season. However, since the fruit shell is very hard and is very mucilaginous, more and more people are finding it inconvenient to use and so use is declining. However, as a wide variety of the processed products (like jam, toffees and fruit powder) have been reported elsewhere, a joint effort was made in Nepal by the Green Energy Mission/Nepal and ITDG/UK to promote value added processing of ripe bael fruit for the local manufacturing and marketing of Bel Jam/Jelly and Squash, mobilizing local Amma Samuha, Babu Samuha and Youth Clubs in four districts of Nepal: Nawalparasi, Bara, Mahotari and Bardiya.

Bael pulp (as the base material, squash, Jam/Jelly or dry powder) can be prepared by following the normal process of manufacturing. The products can be promoted as herbal products. So far, only the production of Bael jam has been carried out to test the marketing of Bael products in Nepal. If this proves successful, it is expected that the resource poor farmers in the production areas could be highly benefited in terms of higher income generation/and rural employment through utilisation and value addition activities of Bael as the fruit is abundantly available, countrywide.

CONSTRAINTS AND ISSUES FACED IN THE DEVELOPMENT EFFORTS

Traditionally, farmers who live in the mountains, hills and remote areas have very narrow options for growing cash crops and collecting wild fruits for additional income because of constraints (the weather conditions, difficult terrain, unavailability of easy transport) that hinder the development/commercialisation of wild fruits although the economic and nutritional significances are well realised.

Besides these, there are many problems and limitations, which have hindered the exploitation and development of underutilised fruits of Nepal. Some of the problems and limitations are:

- lack of reliable statistical data for underutilised fruits
- ignorance of the nutritional/therapeutic and economic value of many of the underutilised fruits
- long gestation period for the commercial production of most of these fruits
- many of these fruits are very specific in terms of climatic requirements

- some fruits are difficult to work with and virtually no propagation and production technology is available for most of the fruits
- small pocket areas, suitable for production/collection, are scattered, hence, virtually no economy of scale could be achieved as making the collection, evaluation and utilisation involves high investment cost
- in the case of fruit development, the Government's main priority programmes are focused on apple and citrus. Programmes for development and expansion of commercially important fruits like banana, pear and mango etc. exist, but there seems to be no policy and programme yet for commercialisation and the wide propagation of underutilised/wild fruits of economic significances
- because of the high risk associated with the developmental aspects, the private sector have so far shown no interest in the promotion of these fruits, except as a hobby.

FUTURE THRUST REQUIREMENT

- Demand and processed products based on fruits are expected to increase as the urban population and *per capita* fruit consumption increases. The domestic production of commercially grown fruits alone may not be sufficient, as we have seen now. As more and more people, both in the urban and rural areas, are becoming health conscious, fruits with more nutritious and therapeutic values could be promoted, fresh or processed, as complementary or substitute for the commercially grown common fruits and their processed products.
- The Department of Agriculture, Horticulture Development Division has made efforts in the introduction, verification and multiplication of major exotic fruit germplasm. At present, there are more than 100 varieties of 15 major fruit crops grown in Nepal. Most of these varieties are exotic and only a few are local or wild. Cultivation of wild fruit trees/shrubs under improved practices and screening for high yielding/quality performing varieties is needed. His Majesty's Government of Nepal should assign/support the related organisations to study in detail the uncultivated food plants that are used as fruits in different locations and in different seasons.
- In view of exploiting the potential of minor fruit crops, the following strategies are recommended:
 1. Generating awareness of the economic, therapeutic and nutritional values of fruits
 2. Collection, evaluation and documentation of indigenous fruit germplasm

3. Identification of underutilised fruits having the potential for development and which could make a valuable contribution to the national economy and health of the people.
4. Preparation of project profiles of such fruits crops for future development
5. Genetic selection of resistant, high yielding trees/bushes
6. Physical, chemical and nutritional evaluation of fruits
7. Development/adoption of propagation and appropriate postharvest loss reduction and processing technologies
8. Find out the ways of adding value to local edible wild fruits by processing and packaging to get a quality product with better shelf-life
9. Standardisation of production technologies, and new product development to meet the needs of both national and international markets
10. Mobilization/formation of local entrepreneurs, preferably women entrepreneurs
11. Policy to support local, regional and international market promotion programmes

CONCLUSION

There is a greater prospect of exploiting these fruits commercially by better conservation and expanded propagation. This is because Nepal has the advantage of diverse agro-climatic regions, a wide variety of fruits (both native and wild) with economic and nutritional and therapeutic values. The time has come to realise that the planned and organised attempts to exploit a few economically valuable underutilised fruits, will ultimately support rural economy through added income from the fruits and value-addition activities at local levels. Thus, we expect that the Government of Nepal will frame out a policy and programme in the 10th Plan to support the development of these fruits and also encourage local farmer groups or cooperatives to take initiatives in establishment, value addition and marketing of the products based on these products.

Such initiatives as off-farm activities in an organised way will yield benefits to the resource-poor through direct income generation and employment. Nepal is not in a position to undertake such a massive operation for the development of underutilised fruits without regional/international cooperation and assistance as it has very limited, competent human resources and R&D facilities to back up the development programme activities at a faster pace. We strongly seek support from international organisations for the technical and marketing support in this endeavour.

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PROCESSING AND MARKETING STATUS OF FRUITS IN PAKISTAN

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Nature has bestowed upon Pakistan a land and climate conducive to the growth of a wide spectrum of fruits (Table 1).

Table 1 Area & Production of Fruits in Pakistan (1999-2000)

Sr. No.	Fruit	Area (Ha.)	Production (Tonnes)
1.	Citrus	197,703	1,943,205
2.	Mango	94,121	937,705
3.	Dates	76,931	579,880
4.	Guava	60,270	494,459
5.	Apple	51,655	377,295
6.	Banana	28,052	125,150
7.	Apricot	12,489	120,488
8.	Almond	10,732	32,336
9.	Grapes	10,433	40,283
10.	Pomegranate	6,770	68,984
11.	Plum	7,039	58,974
12.	Peach	4,806	32,959
13.	Pears	2,941	37,691
14.	Ber (<i>Zizyphus jujuba</i>)	2,376	16,491
15.	Papaya	1,955	20,169
16.	Walnut	1,749	18,025
17.	Jaman	1,489	8,971
18.	Coconut	1,455	7,882
19.	Phalsa (<i>Grewia asiatica</i>)	1,435	6,040
20.	Percimen	1,422	13,586
21.	Loquat	1,279	8,240
22.	Chikoo	1,095	4,882
23.	Cherry	877	1,279
24.	Mulberry	777	3,956
25.	Litchy	420	2,957
26.	Fig	150	889
27.	Pistachio	118	194
28.	Melons	44,197	704,823
29.	Others	32,750	178,749
	Total	657,486	5,846,342

The southern parts of Pakistan provide excellent conditions for the growth of mangos, bananas, citrus and other tropical fruits, while the high mountain ranges in the north and north-west, having extremely cold winters, provide good conditions for temperate fruits like apples, apricots, grapes, etc. The produce of fruit in Pakistan comes from approximately 811,800 hectares or about 4% of the country's cultivated area. The production of fruits in different provinces of Pakistan is reported in Table 2.

Table 2 Production of Fresh Fruits in Pakistan

Province	Production (000 Tonnes)	% Share
Punjab	3072.5	59.6
Sindh	439.3	8.6
NWFP	319.9	6.2
Balochistan	1322.0	25.6
Total	5,153.7	100.00

A large number of fruits are grown in Pakistan (Table 3). Among these citrus fruit shares 37.5% and are considered to be good quality as compared to those produced in other countries. Citrus fruit (37.5) is followed by mango (17%), apple (10.3%), dates (10.3%), guava (8.7%), apricot (3.4%), pomegranate (1%) and banana 4.5%). The remainder constitutes pear, plum, grapes, etc. The composition of fruit production is given in Table 4.

The Middle East countries and Gulf States are important markets for fresh fruits. This market is constantly expanding. The importance of Middle East markets lies not only in their size but also in the close ties which Pakistan maintains with these countries.

Citrus fruits have not only bright marketing prospects in the Middle East but also in Iran and Afghanistan which have been major importers of Pakistan's citrus. Until now exports of the fruit variety from Pakistan to these countries has comprised solely of "*Kinnows*". However, potential also exist for the export of other varieties of citrus such as, lemon, "*Jafa*", red blood "*Malta*" and "*Mosambi*" oranges which have not been exploited as yet.

Table 3 Province-wise Production of Various Fruits in Pakistan (000 Tonnes)

Fruits	Punjab	Sindh	NWFP	Balochistan	Total
Citrus Fruits	1847.3	35.2	34.6	15.7	1932.8
Mango	581.4	285.3	2.1	14.9	883.7
Banana	15.7	49.6	12.7	1.5	79.5
Apple	2.2	0.2	84.6	446.1	533.1
Guava	366.9	20.7	28.1	4.6	420.3
Apricot	0.4	-	18.2	159.5	178.1
Peach	0.9	-	10.1	29.2	40.2
Pears	1.9	-	31.5	0.9	34.3
Plums	0.5	-	35.7	36.1	72.3
Grapes	-	-	1.4	41.5	42.9
Pomegranate	14.4	-	2.1	80.5	97.0
Dates	91.5	30.7	5.9	403.4	531.5
Almonds	-	-	3.1	45.9	49.0
Others	149.4	17.6	49.8	42.2	319.0
Total	3,072.5	439.3	319.9	1,322.7	5,153.7

Table 4 Production Volume of Various Fruits Grown in Pakistan

Sr. No.	Fruit	% Share
1.	Citrus	37.5
2.	Mango	17.1
3.	Apple	10.3
4.	Dates	10.3
5.	Guava	8.7
6.	Banana	4.5
7.	Apricot	3.4
8.	Pomegranate	1.8
9.	Peach, Pear, Plump, Grapes, etc.	6.4

Another fruit which contains great potential for foreign markets is mango. Pakistan grows a large range of both seeded and grafted varieties. Pakistani mangoes are most popular in the Middle East markets because of their specific taste and flavour and therefore, can claim very high prices in these markets. In addition to citrus and mangoes, apples, dates, bananas, apricots, grapes etc, also offer good prospects for foreign markets.

Nonetheless, there exists fairly good competition in the Middle East market. Pakistan's main competitor in these countries is India, especially in the case of mangoes. As regards citrus fruits, Mozambique and USA are close competitors of Pakistan and claim, at present, the major share of the market. However, careful examination of the market trend and elimination of the existing problems for lack of proper packing, grading, transportation and handling in transit etc. can help Pakistan to capture these markets.

PRESENT EXPORT STATUS

Despite favourable conditions for the growth of fruits and also attractive marketing prospects, the export of fresh fruits from Pakistan has been insignificant. Our exports of fruits represent only 4.25% of the total production, whereas some major exporting countries such as Lebanon, Greece, Morocco, Spain etc. export over 50% of their produce.

Unfortunately, the present fruit exports from Pakistan do not represent even a fraction of the exploitable potential of the markets provided by these countries in this field. To quote just one example, it is estimated that the individual market of Saudi Arabia imports over 200,000 tonnes of fresh fruits annually. The biggest items on its import list are oranges, bananas and apples. These fruits are presently being successfully produced in Pakistan, especially oranges which are not only being produced in large quantities but are also of good quality and can capture a huge market.

The major share of Pakistan's export of fruits goes to the various Middle East markets i.e. Saudi Arabia, Kuwait, Oman, Bahrain, Qatar and the United Arab Emirates. Attempts have also been made to diversify exports into markets in the Far East (Singapore, Malaysia), Sri Lanka, and in some European countries. However, these latter efforts have met with limited success. Citrus (*Kinnow*) and mangoes are the main export commodities.

Although prospects for the production of fruits are bright, the bottlenecks are also enormous. There are still some concerns over production, collection, transportation and marketing. Fruits are generally produced by small farmers who lack the capacity of investment for quality and market oriented production. There are no arrangements for grading. The grading and packing arrangements presently existing are extremely unsatisfactory. Inland

collection, storage and transport facilities are unsuitable and inadequate. All these result in high postharvest losses.

Fruits are highly perishable commodities and creation of necessary suitable infrastructure to prolong shelf life is difficult and time consuming. Pakistan has different climatic zones and any plant commodity which has a market abroad can find optimum growth conditions in one place or the other. Pakistan is thus capable of supplying most fruits throughout the year (Table 5).

Table 5 Province-wise Production Period of Fruits in Pakistan

Fruits	Punjab	Sindh	NWFP	Balochistan
Dates	June	June	July	June-July
Apple	Sept-Oct	April	Jul-Sept	July-Sept
Pear	Sept-Oct	-	Jul-Sept	July-Sept
Plum	Sept-Oct	-	Jul-Sept	July-Sept
Peaches	July	-	June-July	June-July
Apricot	July	-	May-June	-
Grapes	-	-	Sept-Oct	Aug-Sept

Agricultural commodities are highly liable to price fluctuations, as prices follow a curve generally in reverse direction to production. To ensure steady supplies over the years the interests of the farmers need to be safeguarded through creation of compensation fund to ensure fair remunerations. The fund would be used to pay subsidies if the decline in prices is below what the government determined as a fair price and replenished through cess when prices register a sharp rise. The export efforts in the field of fruits should be concentrated on Gulf countries and Saudi Arabia. Due to proximity, Pakistan has a natural advantage which should be availed fully. In this connection, collection and dissemination of day-to-day information on market is essential. In spite of the fact that the fruits and the vegetables are produced in abundance in Pakistan, the processing industries which can take care of spoilage, which amounts to 25-30% during peak harvests, need to be developed considerably. Yet it has not developed to the desired level to control the wasting and perishing of fruits, which glut markets during short peak season. Some export figures are given in Table 6.

Table 6 Export of Fruits from Pakistan

Year	Quantity (000 Kg)	Value (US\$)
1992-93	167,736	58,148
1993-94	181,343	54,570
1995-96	135,349	43,756
1996-97	219,306	70,698

FRUIT PROCESSING INDUSTRY IN PAKISTAN

The existing fruit processing industry is concentrated around Karachi, Lahore and Peshawar. About 25 firms are engaged in canning, preservation and bottling of fruit juices. The installed production capacity for the production of squashes, jams, jellies and canned fruits in the country is about 45,000 tonnes. Following are the products along with their quantities being produced by some of the major processing industries of Pakistan (Table 7).

Table 7 Quantity of Fruit Products Manufactured in Pakistan

Product	Quantity Produced (000 Tonnes)
Fruit Preserve	20.2
Jams, Jellies, Marmalades	4.2
Pickles and Chutney	12.50
Tomato Ketchup	13.64
Canned Fruits	16.48
Syrups and Squashes	24.56*

* Million Bottles

Estimated raw fruits annually utilised for processing purposes by the various processing units in the organised sector are present in the table below. Based on the tonnage, Shezan International, Lahore, Mitchell's Fruit Farms, Renala Khurd and Ahmad Food Industries, Karachi are a few major food processors of Pakistan (Table 8).

Table 8 Estimated Raw Product Tonnage annually used by Food Processing Industry in Pakistan

Industry	Raw Fruits Processed (Tonnes)
Shezan International Ltd., Lahore	14,100
Mitchells Fruit Farms, Renala Khurd	8,894
Indus Fruit Products, Multan	3,500
Ahmad Food Industries Ltd., Karachi	3,342
Benz Industries Ltd., Lahore	2,350
Nestle Milkpak Ltd., Sheikhpura	2,012
Bambino Food Industries, Dera Ghazi Khan	2,000
Tops Food and Beverages, Rawalpindi	1,800
Salamat Ali & Sons, Gujranwala	1,780
Firdaus Food Industries, Faisalabad	1,346
Pakistan Fruit Juice Company, Multan	1,275
Suhail Food Industries, Gujranwala	1,200
Veg-Take, Gujranwala	780
K.K. Limited, Peshawar	575

In spite of the fact that the fruits are produced in abundance in Pakistan, the processing industries have not developed commensurate with the increased production and wastage mainly due to the following reasons:

- high cost of packaging material, the cost of tin cans is very high and a limiting factor in development of canning industry
- higher cost of sugar as compared with the international market and as a result thereof, the cost of processed fruit products is increased
- lack of free use of preserved fruit products in daily Pakistani diet
- lack of knowledge with regard to the nutritional value of these products
- absence of publicity with regard to the popularization of the use of processed fruit products.

PRESENT STATUS OF PROCESSING INDUSTRY

Fruit Canning

Capital cost and working capital required for canning industry is very high and canning of fruits is mostly undertaken by some of the major fruit processors on the basis of Armed Forces demand. Canned mango slices, pears and peach halves, fruit cocktail, etc, are among the fruits being presently canned in the country. The local domestic market for these items is very small. However, export markets are being exploited for canned food items in Middle East countries and elsewhere abroad where Pakistanis are

living with whom these food flavours are familiar and desirable. Mitchell's and Shezan's mango slices from grafted species packed in 2½ pounds cans are being exported to Western Europe and USA.

Drying/Dehydration

Sun-dried apricots, figs and raisins are very much relished by the local population but dried products are not very popular in the domestic market, since consumers prefer fresh produce. The dehydration of fruits not only helps the availability of fruits in the dehydrated form during off season at economical price but also reduces the huge losses which are prone to occur on account of their perishable nature.

Fruit Products

Fruit preserves are being prepared on a large scale for domestic use. Beside the three major food processors of the country, a large number of cottage scale food processors are engaged in the production of preservation. Mango pickle, lime pickle, mixed pickle, apple preserve and carrot preserve are popular pickles and preserves, and are available in the country.

- Jams, jellies and marmalades are being manufactured by the Shezan, Mitchell's, Ahmad, Benz and Tops Industries. These are being prepared keeping in view their sale programme. The installed capacity for these products is very large. The present industry is in a position to meet the requirements of 2 to 3 fold additional demand if created.
- Apple jam, apple jelly, mango jam, guava jelly, strawberry jam and orange marmalade are among the popular products prepared by the industry.
- Squashes and syrups are very popular drinks of the country and are in great demand due to hot summer season which lasts for about six months. Major food processors prepare these drinks based on their sale programmes.

Beverages

The fruit drink business is highly profitable and there is a great demand for fruit drinks in the country. Two flavours predominate i.e. mango and citrus. Mango constitutes 90% of total fruit drinks sold in the country.

Incremental expansion by successful processors is the most likely to occur to meet any demand in canned or dried products. Under present market conditions, several fruit drink products show good domestic profit margin.

Increased interest in processed foods by the middle and upper income groups has been noted by several packers, although the market is still very small. The next five year plan envisages increase in the installed capacity from 21,000 tonnes to 46,000 tonnes in the year 2001-2002. Financial provision of Rs. 250 million has also been made in the industrial investment schedule for development of this industry in the private sector. The important policy measures mentioned in the plan are:

1. encouragement of corporate sector/private enterprises with high technology international firms collaborating with local entrepreneurs
2. concessional airfreight arrangement for exports
3. cater to demand for processed items, the processing industries would be accorded duty free access to packing material and imported chemicals. Similarly new units would be encouraged by allowing duty free import of modern machinery
4. setting up of fruit grading units, cold storage and dehydration plants would be encouraged.

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CURRENT INDUSTRY SITUATION OF UNDERUTILISED FRUIT CROPS IN THE PHILIPPINES

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The fruit sector is one of the most important components of Philippine agriculture. The area planted to fruits nationwide is almost 621,861 hectares, representing 4.4% of the total crop land devoted to agriculture and involving about 20 fruit crops. These fruit crops are available for both domestic and foreign markets in either fresh or processed products.

Generally, farmers engaged in fruit production attain higher income than those engaged in other crops. The highest yield of income goes to farmers with greater access to advanced technology, and who avail of the credit and marketing support and services of the government and lending institutions.

Indeed, fruit production plays a vital role in the Philippine economy especially in the areas of security, human health and nutrition, and income generation. Some fruits can be substituted for cereal grains: banana and bread fruit when production of rice and corn (which are the basic staple foods) become insufficient. Other fruits are rich in vitamins and minerals, thus have important influence on human health and nutrition.

Fruits are also important sources of raw materials for processing such as chips, dried, juice, concentrates, purees, jams, marmalade and preserves. It employs thousands of Filipinos in fruit-based processing companies, which are mainly in the small and medium scale (SMEs) enterprises.

Through the years, production, processing and marketing of fruits have been concentrated on bananas, pineapple, mangoes and papaya. There is no doubt that big revenues from these fruits have contributed to the country's foreign exchange. While these fruits are gaining footholds in the local and foreign markets, other fruits such as durian, jackfruit, guyabano, pummelo, mangosteen, rambutan, atis, calamansi (Philippine Lime) balimbing are being developed. All these fruits are gaining popularity and increasing demand both in the local and export markets. The following is a brief status of these fruit crops.

PRODUCTION PROFILE

Durian (*Durio Zibethenius*)

This fruit is a new contribution to the fruit industry. In the 1990s production was limited to Mindanao. Promotion of the production in the country started in 1994 when it was found to be profitable. Like other ASEAN countries, the Philippines has a favourable condition for the production of durian. The varieties grown are Mong Thong, Chanee, Atabrine, Mamer, GD69, Alcon Fancy, Lacson Uno, Arnillo, Puyat Oboza and Duyaya. Major producing regions are: Southern Mindanao, Autonomous Region of Muslim Mindanao (A R M M) CARAGA, Central Mindanao, Western Visayas and Southern Tagalog.

Almost all the country's production of durian is consumed in the domestic market mainly as fresh and for processed products such as ice cream, candies, jam, preserves and juice.

Pummelo

The area planted under pummelo is 2,447 ha and production was registered at 22,705 metric tons in 1998. Major producing areas are: Southern Mindanao, Cagayan Valley, ARRM, Western Visayas and Northern Mindanao.

The country's production, however, is not enough to satisfy demand, considering the increasing domestic market, as well as its potential in the export market, such as Singapore, Hong Kong and others.

In the domestic market, it is being consumed in fresh and as juice concentrates which is further used by juice manufacturers as ingredients and/or flavouring.

Calamansi (*Citronella microcarpa*)

The area planted for this fruit is 12,785 ha and production is 48,734 metric tons. Major producing areas are Southern Tagalog, Bicol Region Western Visayas, Southern Mindanao and Ilocos Region.

Traditionally, calamansi comes in fresh or in processed form such as purees, juice and concentrates. It can also be processed into candies, preserves, jams and jellies. These fresh and processed products are sold both in the domestic and export markets.

Like other citrus fruits, calamansi is rich in Vitamin C and contains a fair amount of calcium and phosphorous. Hot calamansi is also a good remedy for colds and cough.

Mangosteen

This fruit is known as the “Queen of Tropical Fruit”, “most exquisite of the rare fruits”, “finest and best flavoured fruit in the world” (among the marvels of the Far East).

There is limited information on the product. The only proof of its presence is the existence of the fruit as fresh during season and of a processed mangosteen industry in Mindanao.

Production is concentrated in Sulu, Davao and Cotabato. Recently, some plantations have been monitored in some areas in Southern Tagalog and Western Visayas provinces. The area planted is 1,200 ha and total production is 5,200 metric tons.

Mangosteen supply remains scarce. Maybe because some of the farmers have not yet realised the very high economic potential that this product offers to the Philippine economy, considering its biggest prospects in both the domestic and export markets. It's only now that this product among others, is gaining importance by the government because it can be processed as well as can be eaten fresh.

The majority of the supply for the Manila based customers and that of Cebu came from Jolo, Sulu, Cotabato, Lanao and Davao. Some are also from Batangas, Laguna, Quezon and Mindoro.

Mangosteen can be used in fruit salad or compote served with ice cream or puree for sauce or sorbets, or eaten fresh.

Rambutan

Like mangosteen, there is no available data for hectareage planted for rambutan. Major producers are: Southern Luzon, Southern Mindanao, Central Mindanao, Northern Mindanao and Western Mindanao.

Until now, there is minimal significance of this product in fruit statistical data. Due to insubstantial trading and the lack of an established market for the product, it is merely classified under “others”.

Processed rambutan, specifically the canned and syrup-dipped ones, is popular among Filipino consumers, for medicinal reasons. The roots of the rambutan

tree are used in concoction to treat fever, the bark to cure tongue diseases, and the leaves can be used for dressing wounds.

Jackfruit

The area planted under jackfruit is 13,540 ha with a yield of 90,540 metric tons. Major producing areas are Mindanao, Western Visayas and Southern Luzon.

The product is one of the most promising secondary fruit crops considering its growing demand both in the local and export markets. Supply, however, like the rest of the fruits, is limited at the moment. Private plantation farms have ventured in the growing of this fruit. However, it will take sometime before this will finally bear fruit.

The low supply is an effect of adverse climatic conditions, while the relatively high cost of equipment and other inputs affect processing.

Guyabano

This product is being used as a raw material in the processing of juices, concentrates and purees. Production however has been insufficient to meet the demands of Filipino households and processors.

The area planted for this product is 3,073 ha, and production volume is 8,574 metric tons. Major areas where the product is grown are Mindanao, Southern Visayas and Southern Luzon.

Like other potential fruit crops, there is still insufficient data on the major players and processors of guyabano.

PROCESSING PROFILE

Any fresh fruits grown in the Philippines can be processed: dried/dehydrated, juice/puree/concentrate and preserved in syrup/brine. However, the most common fruits that are processed are pineapple, mangoes, banana, calamansi, tamarind, passionfruit, papaya, oranges, guava and guyabano.

Aside from calamansi, pummelo and jackfruit, other tropical fruits such as atis, anonas, balimbing, mangosteen and rambutan are not significantly used in processing mainly due to their supply and varietal problems.

Below is the status of processing technologies of the following underutilised fruit crops:

Guyabano

Aside from eating this fruit fresh, it is already commercially available as ready to drink juice. Guyabano puree is also a good prospect for processing as well as guyabano powder. Although supply is not enough, guyabano processing is a boom market both for domestic and export.

Annonas

Mostly these are consumed fresh since they are not yet utilised for processing. There is no known processing technology/process for these fruits at the moment.

Atis

Just like annona, this fruit is commonly consumed fresh. However, other processors use the fruit as flavouring for ice cream.

Jackfruit

Although seasonal, jackfruit is considered an economically important crop with a potential market especially for the processed form. This fruit is processed into fruit preserves which can be used as desserts and toppings for ice cream. Other technologies include dried and vacuum dried jackfruit. As a delicacy, jackfruit is processed into pastilles and candies.

Calamansi

This is another economically important crop belonging to the citrus family. Calamansi is also known as the Philippine lime. This fruit is processed into concentrate and ready-to-drink juice. Calamansi is also available in powdered form. Right now, the demand for calamansi concentrate is increasing both in the domestic and export markets.

Pummelo

Also from the citrus family, the pummelo/mandarin is a high-value product not only eaten as fresh but also processed into ready-to-drink juice. Pummelo is also available commercially in powder form.

Mangosteen

Mangosteen is a high-value commodity usually processed into sweet delicacies like pastilles and candies. The market is usually limited in the region, and scale of production is limited to household capacity.

Guava

It is a fruit rich in Vitamin C, but because of its low supply and value, market of guava product is not a boom. Guava is known for its juice. As a pectin producing fruit, it is also being processed into jelly in commercial quantity.

Balimbing

Balimbing, also known as the star fruit, is commonly made into fresh juice used mostly in hotels.

MARKETING PROFILE

Domestic

In general, the bulk of production of these products is supplied to the domestic market. However, due to seasonality of supply and scarcity of these fruits, there is not enough statistics to monitor its operational flow. Such scarcity and seasonality of supply reflects on the price. Farmgate prices vary from one source to another.

Producers/traders deliver the product to Metro Manila outlets. Prices vary mainly with the season. Most of the fruits coming from Mindanao are gathered in Davao. Some of these are being collected by traders or deposited in various buying stations/centres located in major producing regions.

These fruits are then shipped by marketing intermediaries. The high cost of shipping also affects the cost of the products when it is finally passed on to the fruit vendors/stores. Due to insufficient/high cost of transport, a large part of production of some fruits from Mindanao i.e. mangosteen, durian, end up in Malaysia and Indonesia via the Southern backdoor which provides more efficient and available transport from the Sulu archipelago.

Export

Export of these products is insignificant except for jackfruit, guyabano and

calamansi. Mangosteen recorded minimal export sales of US\$ 3,000 (4,114 kg) to Hongkong in 2000 and US\$ 163 (326 kg) to Taiwan in 1995.

Exports of jackfruit in the dried form was valued at US\$ 467,304 (217,938 kg) in 2000. The bulk of the shipment went to the USA 63.91%, Canada 5.98%, Japan 3.68%, Saudi Arabia 2.71% and Great Britain 2.70%.

In 2000, guyabano registered an export of US\$369,947 (317,838 kg) to USA 61.05%, Canada 16.61%, Japan 13.23%, Micronesia 1.52% and Guam 1.15%. Exports of calamansi on the other hand, amounted to US\$257,001 in 2000. This was mainly shipped to USA 39.27%, Korea 21.16%, Japan 15.87%, Canada 21.07% and Hongkong 8.81%.

Stiff competition in the world market is eroding the country's market position. Competitiveness is affected by high production costs. Despite the enormous potential of our fruit crops, production is still limited. Even the domestic market is undersupplied. This is why most of the country's high-potential fruit crops are underutilised.

PROGRAMMES BEING PURSUED BY THE GOVERNMENT

The various agencies in government are working very closely with private entities, farmer groups and other interested groups and individuals for the improvement of these products. The Agriculture Fisheries Modernization Act (AFMA) Medium Term Development Plan, the Philippine Export Development Plan of the Departments of Agriculture, Science & Technology and Trade & Industry support the development and improvement of agriculture and food products to be competitive in both domestic and world markets. The plans specifically provide policy reforms and measures for the provision of more efficient rural information systems which would include rural transport and communication infrastructure that would lower the cost of production. It also strengthens research and development (R&D) on appropriate production technologies, provision for more reliable market information, provision for better irrigation systems, support for the development of cooperatives, and increase postharvest handling and processing facilities.

Steps toward the adoption of e-commerce or electronic data interchange (EDI) in export-import documentation and processing have also been initiated.

In the area of market access, the Philippines has embarked on an Accreditation Programme for the food exporters/processors. The programme aims to improve the quality of processed foods to increase exports. The accreditation also strengthened and harmonised the certification schemes in government.

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STATUS REPORT ON THE POSTHARVEST HANDLING, PROCESSING AND MARKETING OF UNDERUTILISED FRUIT CROPS IN SRI LANKA

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INTRODUCTION

Sri Lanka is a tropical island with 24 different agro-ecological regions and two monsoons or major rainfall periods. This enables the production of a wide variety of exotic edible fruits. As in the case of many other developing countries, a major part of these commodities is produced in home gardens and is usually available only in local domestic markets. Thus many fruit species continue to remain unknown and underutilised. Commercial exploitation of such species could provide income-generating opportunities in rural communities, and earn valuable foreign exchange for the country if identified as exportable commodities. However, this can only be achieved via the prior identification of prospective markets, organised production of adequate volumes of the respective commodities and by achieving the quality requirements and standards stipulated by the markets for which they are produced.

Organised production entails optimizing of yields via the selection of appropriate varieties and the adoption of husbandry techniques most suited to this purpose. Research inputs and efforts need to be strengthened so that technology could be effectively transferred to growers without delay. Some fruit crops with potential for further commercial development and promotion in Sri Lanka are listed in Table 1.

Table 1 Underutilised Fruit Crops Grown In Sri Lanka

Fruit (1000MT)	Extent (Ha)	Production (1000MT)	Export #
Beli (<i>Aegle marmelos</i>)	**	**	**
Billibmi (<i>Averrhoa bilimbi</i>)	**	**	**
Breadfruit (<i>Averrhoa bilimbi</i>)	5,422	53,448	**
Custard apple (<i>Annona cherimola</i> Miller)	**	**	**
Durian (<i>Durio zibethinus</i>)	**	**	**
Guava (<i>Psidium guajava</i>)	1,042	**	145
Jackfruit (<i>Artocarpus heterophyllus</i>)	48,225	266,589	**
King coconut (<i>Cocos nucifera</i>)	**	**	**

Fruit (1000MT)	Extent (Ha)	Production (1000MT)	Export #
Lime (<i>Citrus aurantifolia</i>)	7,337	129,295	48,475
Mangosteen (<i>Garcinia mangostana</i>)	**	**	2,742
Passionfruit (<i>Passiflora edulis</i>)	507	7,263	**
Pomegranate (<i>Punica granatum</i>)	412	**	**
Pummelo (<i>Citrus maxima</i>)	**	**	**
Rambutan (<i>Nephelium lappaceum</i>)	2,015	**	**
Sapota (<i>Manilkara zapota</i>)	**	**	**
Sour sop. (<i>Annona muricata</i>)	**	**	**
Tamarind (<i>Tamarindus indica</i>)	**	**	1,045,486
Wood apple (<i>Limonia acidissima</i>)	3,302	**	**

Source: Statistics obtained from the Department of Agriculture and the Sri Lanka Export Development Board.

* Information not available # Fresh and processed products

POSTHARVEST HANDLING

Most of the above varieties of fruit are grown in home gardens and pass through a complex marketing sequence prior to reaching the consumer. While accurate figures for these fruits are not available, observations on postharvest loss of other fruits grown in Sri Lanka such as mango, (Wilson Wijeratnam, R.S. and Selvarajah, K., 1991), and banana (Wilson Wijeratnam and Hewage, S.K., 1992), indicate that postharvest losses could be expected to range between 40-60% of the harvested crop. It is important therefore to develop/adapt and transfer technology that will minimise these losses, as a first step towards promoting the marketing of these underutilised fruits as fresh as well as value added products in both domestic and for more lucrative export markets.

Postharvest losses occur during all stages of the complex marketing sequence to which fruits are subjected. Fruits are often picked either immature or at an advanced stage of maturity where inherent physiological developments render them more susceptible to injury when subjected to rough handling at time of harvest and subsequently during sorting / grading and transportation. Traditional methods of harvesting fruits such as jackfruit, durian and mangosteen for example, result in heavy losses.

Packaging used by traders, does not accommodate or compensate for bad road surfaces or high ambient temperature and humidity conditions that prevail during extended periods of transportation. Thus fruits are often observed to be bruised, infested by postharvest pathogens and rendered unfit for human consumption on reaching respective distribution points. While technology is available to prevent such losses, farmers and others engaged in

the trade often lack the resources to invest in such methods and are therefore unable to minimise loss.

At present, only exporters and those catering to sophisticated upmarket establishments have moved away from inferior rustic packaging materials such as jute sacks and cane baskets. These individuals have adopted the use of polystyrene sleeving, cardboard separators, the use of plastic crates and corrugated cardboard cartons, which are more suited toward maintaining quality for the transportation of perishable horticultural commodities.

A few research programmes have been initiated in Sri Lanka to identify varieties with good postharvest handling characteristics, and to develop necessary postharvest handling procedures and solve specific postharvest problems associated with selected varieties of underutilised crops. One such fruit is the rambutan, where postharvest handling procedures have been investigated with some success. However much remains to be done with respect to other underutilised fruit crops.

In this context, sharing of information between countries participating in a regional programme such as that being discussed at this meeting, would prove valuable and would facilitate the efficient use of scarce resources available for R&D activities in most participating countries.

PROCESSING

At present limited volumes of various underutilised fruits are processed at different levels of sophistication. In rural environments for example, farmers process commodities such as bilimbi, tamarind, lime, jack and breadfruit in various forms for domestic consumption. These traditional methods of preservation have developed into cottage industries in some cases and such produce is then marketed in urban domestic markets. Some cottage industry operations may also engage in supplying larger processing plants with semi-processed products. However, in most cases packaging is poor and needs to be improved in order to extend the storage life to be attractive to the consumer.

Larger processors have ventured into canning commodities such as jackfruit segments, beli and wood apple cream; and bottled king coconut water for export to overseas markets. Available processed products of selected underutilised fruits are presented in Table 2. It is noted that statistics for production and processed volumes with respect to many of these commodities are not available at present. However steps have been taken by the Agriculture Division of the Sri Lanka Department of Census and Statistics to compile such information for the year 2002.

Prerequisites for promoting commercially viable processing industries of these fruits include availability of raw material, economic viability of the processing operation, marketability of products, availability of technology to meet market requirements, necessary machinery and equipment, and adequate and easy access to necessary support services (Wilson Wijeratnam, R.S., 1998).

It is essential to ensure that these prerequisites are available in order to promote entrepreneurial activity and fully exploit the commercial potential of these underutilised crops. It is also noted that the provision of these prerequisites must be coupled with careful and thorough market research. Adequate volumes of fresh and processed products should be produced only when markets for these products are available.

Many of the prerequisites mentioned above need to be satisfied if the potential behind the marketing of underutilised crops is to be fully exploited in Sri Lanka.

Table 2 Processed products and Technologies Available in Sri Lanka for Selected Underutilised Fruits

Fruit	Processed Product
Beli (<i>Aegle marmelos</i>)	cream, juice, candy
Bilimbi (<i>Averrhoa bilimbi</i>)	chutney, pickle, salted and dehydrated,
Breadfruit (<i>Artocarpus altilis</i>)	canned, dehydrated, minimally processed
Custard apple (<i>Annona cherimola</i>)	Ready-To-Serve (RTS) drink
Durian (<i>Durio zibethinus</i>)	cream, minimally processed, fruit bars, roasted seeds
Guava (<i>Psidium guajava</i>)	RTS drink, canned fruit, jelly
Jackfruit (<i>Artocarpus heterophyllus</i>)	canned, minimally processed, dehydrated, pickled, curry, cordial, syrup, dried seed products including seed flour for confectionery items
King coconut (<i>Cocos nucifera</i>)	minimally processed, bottled drink
Lime (<i>Citrus aurantifolia</i>)	pickle, cordial, salted and dried
Mangosteen (<i>Garcinia mangostana</i>)	fresh fruit only
Passionfruit (<i>Passiflora edulis</i>)	cordial, frozen pulp, jam, juice
Pomegranate (<i>Punica granatum</i>)	ripe seed, syrup, juice, wine
Pummelo (<i>Citrus maxima</i>)	mix fruit cordial, candied peel
Rambutan (<i>Nephelium lappaceum</i>)	canned fruit in syrup
Sapota (<i>Manilkara zapota</i>)	fresh fruit only
Sour sop (<i>Annona muricata</i>)	RTS drink, canned pulp

Fruit	Processed Product
Tamarind (<i>Tamarindus indica</i>)	sauce, chutney, paste, concentrate, cream, fruit bars, candy
Wood apple (<i>Limonia acidissima</i>)	jam, pulp, canned cream, RTS drink, fruit bars

Source: Ediriweera, N.(2002), Head Agro-Food Technology Division, ITI, personal communication ,and “Tropical Fruits of Sri Lanka” Publication of the Department of Agriculture, Extension and Communication Centre, Peradeniya (1997), Ministry of Agriculture,Sri Lanka .

MARKETING

Most horticultural products pass through a long and complex marketing sequence, leaving ample room for heavy postharvest loss at each stage. The grower is distanced from his markets, and has no direct access to market information. He is therefore unable to keep abreast with the requirements of the markets he expects to service either in terms of products or product quality.

Markets available for underutilised crops include domestic and export markets respectively. Domestic markets include co-operatives and small retail outlets, small and medium sized restaurants, the more sophisticated super markets and tourist hotels. These commodities may also be marketed when organically produced, as health foods.

Export markets include ethnic markets in European and Middle Eastern countries. These markets are less discerning as they cater to migrant populations who are familiar with these exotics and are not meticulous about the quality of the fresh products. Few if any underutilised fruits are exported to sophisticated overseas markets at present.

Thus optimum utilisation of the lesser-known edible fruits of Sri Lanka continues to pose a challenge to scientists and entrepreneurs. Scientists need to pursue effective research programmes. Records of relevant genetic materials with respect to available varieties for the different species of underutilised crops must be maintained. Varieties suitable for commercial production need to be identified with respect to their market potential. Researchers also need to develop efficient methods of propagation, production, as well as postharvest handling and processing, respectively. Most importantly researchers need to ensure that the technology developed by them reaches those in need of it.

Entrepreneurs on the other hand must be provided with access to adequate financial and infrastructural facilities. They must be encouraged to work

together with small farmers and venture into commercial operations in new agricultural areas with careful planning and a knowledge of the markets they wish to tap.

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PROCESSING AND MARKETING OF UNDERUTILISED FRUITS OF THAILAND

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INTRODUCTION

Thailand is one of the ASEAN countries with approximately 20 million hectares or 41% of land for agricultural use. The fruit planting area in this country is about 1.4 million hectares or approximately 7% of the total agricultural land. Due to differences in climate conditions, fruit planting area can be roughly divided into 6 zones (Figure 1), and different fruit varieties which have been grown in different zones are as follows.

Zone	Fruit varieties
Upper North	Longan, lychee, tangerine, mango and certain temperate fruit varieties such as peach, pear, nectarine, persimmon etc.
Lower North	Banana, mango, lime, pummelo, tangerine and tamarind (sweet)
Northeast	Cashew nut, annona, mango (for processing), papaya, tamarind (sweet and sour)
Central	Banana, mango, tangerine, pummelo, rose apple, jackfruit, sapodilla, papaya, santol, young coconut and pineapple
East	Durian, rambutan, mangosteen, mango, salac, langsat and pineapple
South	Rambutan, durian, mangosteen and longkong

FRUIT PRODUCTION

The total fruit planting area for the last 5 years had increased from 1.1 million hectares in 1994 to 1.4 million hectares in 1998 or about 4% average annually. However, the average increase in total yield at the same period was approximately 1% annually, from 9.43 million tones in 1994 to 9.61 million tones in 1997 or even decline to 8.49 million tones in 1998. The yield variations or reduction were mainly due to the fluctuations in the weather conditions. Tables 1 and 2 showed the figures of planted areas and yields of 31 economic fruit crops grown between 1994 and 1998.

The planting areas of tamarind, jackfruit, mangosteen, annona, pummelo and jujube which are the underutilised fruits under UTFANET were about 0.2 million hectares or approximately 19% of the total fruit planting area and

their yields were about 1.2 million tones which is approximately 14.2% of the total fruit production.

Figure 2 shows that banana, guava, papaya and young coconut are the only four species which produce fruits all year round. The rest are seasonal crops and some have rather short fruiting season. However, most of the Thai fruit under UTFANET seem to have rather short or medium fruit production periods.

FRUIT PROCESSING

For the next five years, the increase in total production can not be expected because fruit producers will focus on export quality rather than quantities. Although there is an encouraging atmosphere in investment in the fruit processing industry which requires the fruits as raw materials in marketing processed products, the growers still prefer to sell their products to the fresh market due to higher prices rather than to the processing plants which they can expect to get lower prices. So only surplus or out-of-fresh graded quality fruits will reach the processing plants. However, certain fruit varieties such as pineapple, mango, star gooseberry and sour tamarind have been grown specifically to serve the processing industry.

In Thailand, 2 types of fruit processing activities exist: industry and home. The processing industry level is primarily engaged with certain large scale production varieties such as pineapple, longan, mango, rambutan and papaya and the main products are in canning. The home processing will be concerned with large, medium and small scales or even wild species, and their products will be in various types, such as preserved, paste, fried, juice and etc. Table 3 shows the home processing products of certain small scale production varieties and also of the fruits under UTFANET. These home processing types adapted very well with the “One-product One-village” project which is one of the programmes in government policy to solve the country economic crisis problems at grass root.

FRUIT MARKETING

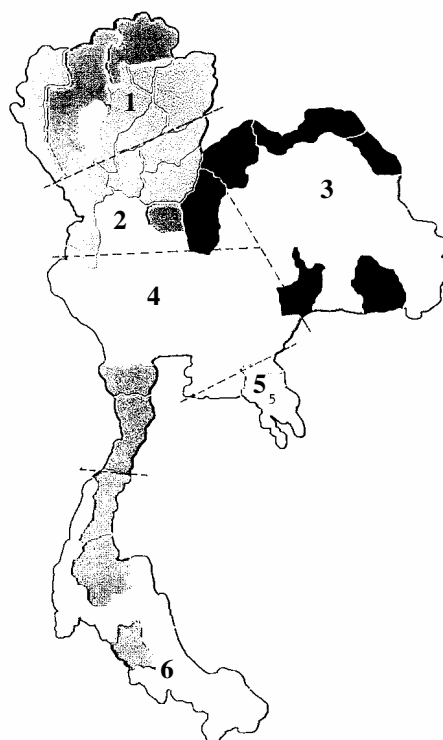
Figure 3 shows the fruit marketing pattern in Thailand. Fruit collectors or middlemen play key roles in the fruit marketing system. The collectors usually collected the produce from the growers. They then send the fruits to the wholesalers, processing plants, retailers or directly to the consumers. Some growers may sell their produce to the wholesalers, processing plants or directly to the consumers. The wholesalers will send the products mainly to the retailers and exporters.

Processed products from the processing plants will be distributed to the retailers or exporters, but mainly sold direct to the consumers or to be sold in the shops on consignment basis.

The marketing of both utilised and underutilised fruits is mainly for domestic consumption. Only 0.1-10% of the products are exported to nearby countries in Asia and very small quantities to more distant countries. The volumes and values of export of fresh and processed fruits for the last five years were shown in Table 4 and 5 respectively.

Guava, mangosteen, pummelo and anona are only four fruits under UTFANET among the fresh exported varieties with their volumes of about 22,000 tones and their values of about 400.4 million baht or approximately 8.60 and 7.76% of the total volume and value of fresh exported fruits, respectively. For processed products, only frozen mangosteen, dried tamarind and canned guava are among the export items with their volumes about 25,400 tonnes and values about 420 million baht or approximately 31 and 15% of total export volumes and values, respectively.

Figure 1 Thailand fruit production zones



1 = Upper north, 2 = Lower north, 3 = Northeast, 4 = Central, 5 = East and 6 = South

Figure 2 Production period of Thai fruits.

Varieties	Fruiting season											
	J	F	M	A	M	J	J	A	S	O	N	D
Mango												
Banana												
Durian												
Tamarind												
Longan												
Rambutan												
Pineapple												
Jackfruit												
Langsat												
Mangosteen												
Anona												
Lime												
Young coconut												
Pummelo												
Cashew nut												
Tangerine												
Papaya												
Lychee												
Santal												
Guava												
Rose apple												
Sapota												
Grape												
Jujube												
Marian plum												
Sweet orange												
Passionfruit												

Source: Department of Agricultural Extension

Figure 3 The marketing pattern for Thai fruits

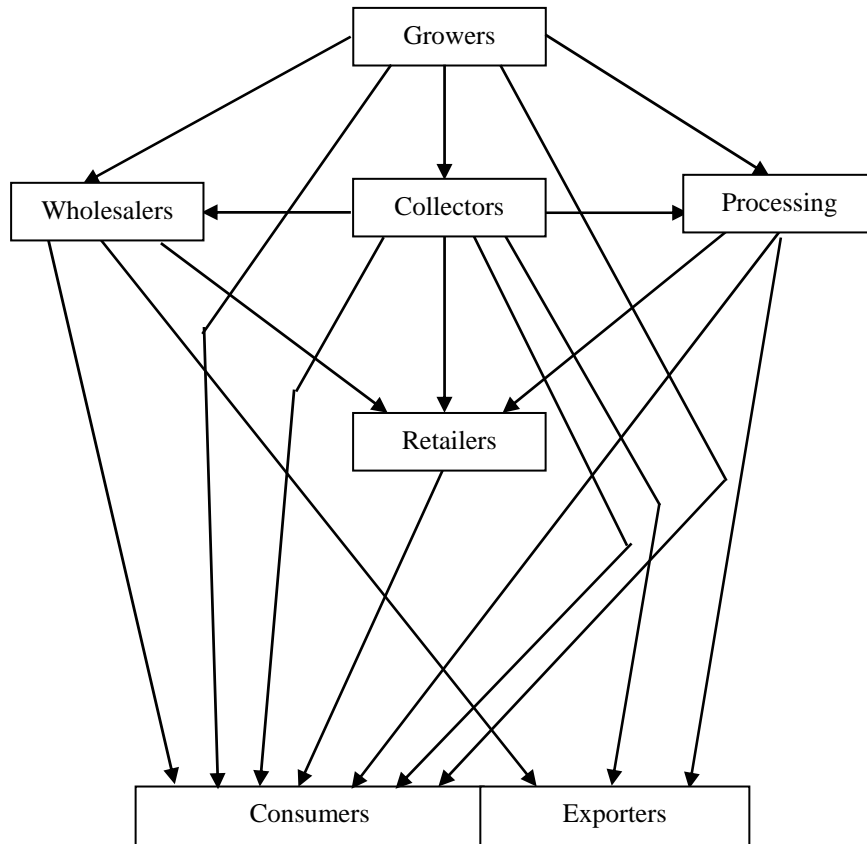


Table 1 Fruit planting area in Thailand between 1994-1998
(1 hectare = 6.5 rai)

No.	Varieties	Planted area (Rai)					%
		1994	1995	1996	1997	1998	
1	Mango	1757050	1887583	1990052	2188538	2153004	23.25
2	Banana	861750	887609	932089	972207	1048271	11.32
3	Durian	722454	8001525	843071	855029	860304	9.26
4	Tamarind	495673	557336	587058	652704	660764	7.14
5	Longan	297184	338968	405465	493214	546133	5.90
6	Rambutan	433453	468323	505466	536488	540254	5.84
7	Pineapple	624485	620591	610411	529361	511710	5.53
8	Jackfruit	254533	265845	278093	311436	324036	3.50
9	Longkong & Langsat	227442	255470	280855	291342	316147	3.41
10	Mangosteen	213747	236666	267914	284490	292604	3.16
11	Annona	275820	276948	294852	284563	262598	2.84
12	Lime	168118	183999	199872	215796	231682	2.50
13	Young coconut	123859	156270	166457	196667	227282	2.45
14	Pummelo	130363	162640	186207	204758	210269	2.27
15	Cashew nut	346299	293011	253816	251732	202975	2.19
16	Tangerine	221520	264039	271920	152933	185644	2.00
17	Papaya	161552	153280	159520	151759	170753	1.84
18	Lychee	95505	95180	107657	119988	135215	1.46
19	Santol	--	--	--	99119	97191	1.05
20	Guava	40016	47444	60049	67747	71769	0.78

No.	Varieties	Planted area (Rai)					%
		1994	1995	1996	1997	1998	
21	Rose apple	22241	30049	37617	50184	66016	0.71
22	Sapota	53964	51643	59176	62682	65403	0.71
23	Grape	18546	15756	16531	15816	16947	0.18
24	Jujube	17147	14722	16477	16158	16940	0.18
25	Marian plum	8230	9857	10418	12798	12635	0.14
26	Peach	7277	9248	7138	13108	11359	0.12
27	Salac	7820	8656	10457	6948	8762	0.09
28	Sweet orange	5784	5205	4772	6805	5254	0.06
29	Passionfruit	3850	3005	3212	2742	4824	0.05
30	Pear	834	840	1116	1453	1319	0.01
31	Necked tangerine	1156	1254	1282	1253	1194	0.01
TOTAL		7591572	8103539	8327000	9047707	9258654	100

Source: Department of Agricultural Extension

Table 2 Fruit yield in Thailand between 1994-1998.

No.	Varieties	Yield (ton)					%
		1994	1995	1996	1997	1998	
1	Mango	1259990	1207914	1203683	1190396	995652	11.73
2	Banana	1331755	1441750	1633643	1734555	1577611	18.59
3	Durian	780393	927194	915822	966747	797343	9.40
4	Tamarind	140816	142209	135518	159805	166546	1.96
5	Longan	143196	128128	197299	236335	17555	0.21
6	Rambutan	608246	643152	642547	725126	629267	7.42
7	Pineapple	2589302	2375311	2262678	2083390	1787442	21.06
8	Jackfruit	425749	452763	464352	512427	523386	6.17
9	Longkong & Langsat	87343	103075	98514	111138	135919	1.60
10	Mangosteen	110204	128280	142516	183255	155044	1.83
11	Annona	228105	236578	242504	233516	207896	2.45
12	Lime	99458	98351	116962	160883	172605	2.03
13	Young coconut	66999	102740	117059	134047	120347	1.42
14	Pummelo	81558	87589	97181	121956	124570	1.47
15	Cashew nut	58359	55034	47956	54493	34622	0.41
16	Tangerine	584245	585469	523729	272300	283800	3.33
17	Papaya	367984	342772	333741	295156	367861	4.33
18	Lychee	46879	35776	60320	58873	8328	0.10
19	Santol	24340	27441	30620	38265	38358	0.45
20	Guava	90921	101784	120928	110400	135910	1.60
21	Rose apple	22319	36304	39257	70414	65469	0.77

No.	Varieties	Yield (ton)					%
		1994	1995	1996	1997	1998	
22	Sapota	55495	56102	48649	51646	47371	0.56
23	Grape	56416	40491	39115	33800	31677	0.37
24	Jujube	33171	31441	32055	28600	28326	0.33
25	Marian plum	6162	6502	6127	9045	5201	0.06
26	Peach	3182	3387	4150	3151	2934	0.03
27	Salac	5406	6636	9125	8336	8739	0.10
28	Sweet orange	13334	9502	9040	10808	8625	0.09
29	Passionfruit	6694	5415	5581	4967	8669	0.10
30	Pear	345	125	219	623	547	0.01
31	Necked tangerine	802	648	676	648	621	0.01
TOTAL		9329168	9419863	9581572	9611103	8486329	100

Source: Department of Agricultural Extension

Table 3 Processed products from underutilised fruits

Fruit	Products
Guava	Preserved guava Juice
Jujube	Jujube paste
Star gooseberry	Preserved stargooseberry
Jackfruit	Dried jackfruit Jackfruit leather Crispy jackfruit
Tamarind	Preserved tamarind Tamarind in salt and sugar Tamarind juice Tamarind concentrate
Mangosteen	Mangosteen paste
Pummelo	Pummelo in salt and sugar Pummelo jam Pummelo glacé

STATUS OF PRODUCTION, PROCESSING AND MARKETING OF SOME UNDERUTILISED TROPICAL FRUITS OF VIETNAM (JACKFRUIT, MANGOSTEEN AND PUMMELO)

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GENERAL INTRODUCTION

Vietnam is located in the Southeast Asia region, between the latitude of 8.5 to 23.4° N and Longitude of 102.1 to 109.4° E with area of 330,990 sq km and population of 76.3 m people.

The climate of Vietnam is influenced by both typical tropical (the South of Vietnam) and sub-tropical conditions (the North of Vietnam in the winter). Diversification of climate and soil conditions has made Vietnam diverse in fruits crops.

For many Vietnamese households, especially for those of ethnic minorities in the remote areas, underutilised fruit crops such as jackfruit, mangosteen and pummelo play an important role in their livelihood. It is a source of their income. Therefore the underutilised fruit crops development is considered to be one of the priorities in the Vietnam's Government programme: "*Eradicate hunger and alleviate poverty*" as it plays an important role in improving living standards of the local people.

The production of underutilised tropical fruit crops is still unsustainable due to many problems (inefficiency in variety selection, postharvest, processing technology and marketing etc.). Therefore, the overall evaluation of the problems in processing and marketing is of great importance.

PRODUCTION, PROCESSING AND MARKETING OF UNDERUTILISED TROPICAL FRUITS

Jackfruit

Originally a native to India, the jackfruit (*Artocarpus integrifolius*) is now widely cultivated throughout the hemispheres. Wild jackfruit is found in the Western ghats of India.

It is commonly grown in Malaysia, Indonesia, Philippines, Burma, Brazil, Indo-china including Vietnam and in some other tropical countries. It is a medium-sized tree, 8-10m tall, having a dense irregular globose crown.

The sap is milky white. The leaves are dark green.

Jackfruit is a perennial plant. It can grow on a wide variety of soil although it prefers to a rich, deep alluvial soil. Soil drainage is importance. Sub-soil drainage congestion, rise in water table or flood severely damage the trees and may lead to death.

Warm humid plains are suitable for jackfruit. It also flourishes in humid hill slopes up to an elevation of 1,500m. Quality of fruits deteriorates in higher altitudes. It also grows well in arid and warmer plains. Cold weather and frost are harmful.

Seedling jackfruit trees start bearing fruit from 5th-7th year onward while the grafted ones from 3rd, when a few fruits may develop. The trees attain peak bearing stage in about 15-16 years of planting. At this stage, normally a tree can bear up to 250 fruits annually. The weight of fruits varies depending on the type. On an average about 40-50 tons of fruits/ha could be obtained.

Jackfruit is grown mainly in the midland areas in household gardens intercropping with other crops. According to the statistical data, total annual jackfruit production of Vietnam is estimated nearly 80,000 tons. Distribution of jackfruit in Vietnam is shown in the table below.

Table 1 Distribution of jackfruit in Vietnam

Regions	Provinces
North	Lang Son, Bac Giang, Vinh Phuc, Phu Tho, Thai Nguyen, Hoa Binh
Central	Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien Hue
South	Dak Lac, Lam Dong, Dong Nai, Binh Phuoc, Hau Giang, Tien Giang

Composition and use

Having a good texture and attractive colour, Jackfruit wood is widely used for making home furniture and fine handicrafts. Furniture from jackfruit wood is preferred in Vietnam.

Jackfruit leaves are a good feed for cattle. The young jackfruit leaves are known in Vietnam as an oriental traditional medicine for curing the agalactia (agalactosis) of mothers with babies.

Nutritive value of jackfruit

Each mature jackfruit tree can bear up to 300 fruits annually, each fruit weighs 5-15kg of which edible part 29%, skin and edible fibre 50%, seed 12% and others. Ripe fruit has high nutritive value.

Table 2 Composition of jackfruit (flesh)

Variety	Water	Protein	Sugar	Cellulose	Ash
Dai	85.4	0.6	11.4	1.2	1.4
Mat	82.2	1.5	14.0	1.2	1.1

Jackfruit seed is a valuable food. It contains 48% water, 37.6% starch, 5.2% protein, 1.6% cellulose, 1.4% minerals.

Harvesting, Ripening and storage

Tender jackfruits are harvested for use as a vegetable during early spring and summer. The fruit matures towards the end of summer in June. The period of fruit development is February to June. The optimum stage of harvest maturity of jackfruit has been reported to be 90-110 days after the appearance of the spike. Harvesting is done by cutting off the footstalk carrying the fruits.

In most cases ripening is not a problem. The fruit ripens when the maximum temperature is reached during the end of the summer season. In colder regions, the fruit may mature late. Jackfruit is not normally stored in cold storage. The fruits can be stored for up to 6 weeks under conditions of temperature 11-13°C and 85-90% RH. The initial quality of jackfruits and stage of maturity at harvest are important factors on which the storage life depends.

Processing of jackfruit

Jackfruit is mostly used fresh. The main products of processed jackfruit are dried jackfruit (jackfruit chips), frozen jackfruit, pickled jackfruit, canned jackfruit, jackfruit nectar, jackfruit strong drink etc. Jackfruit “farsi” (jackfruit stuffed with mixture of minced pork and jackfruit seed powder), jackfruit salad, pickled jackfruit and jackfruit cake are popular food of people in the central part of Vietnam.

The rind of jackfruit is a good source of pectin. Extract from the rind can be used for making jelly. Skin and core of jackfruit could be used commercially for pectin extraction.

Figure 1 Processing flow-sheet for jackfruit farsi

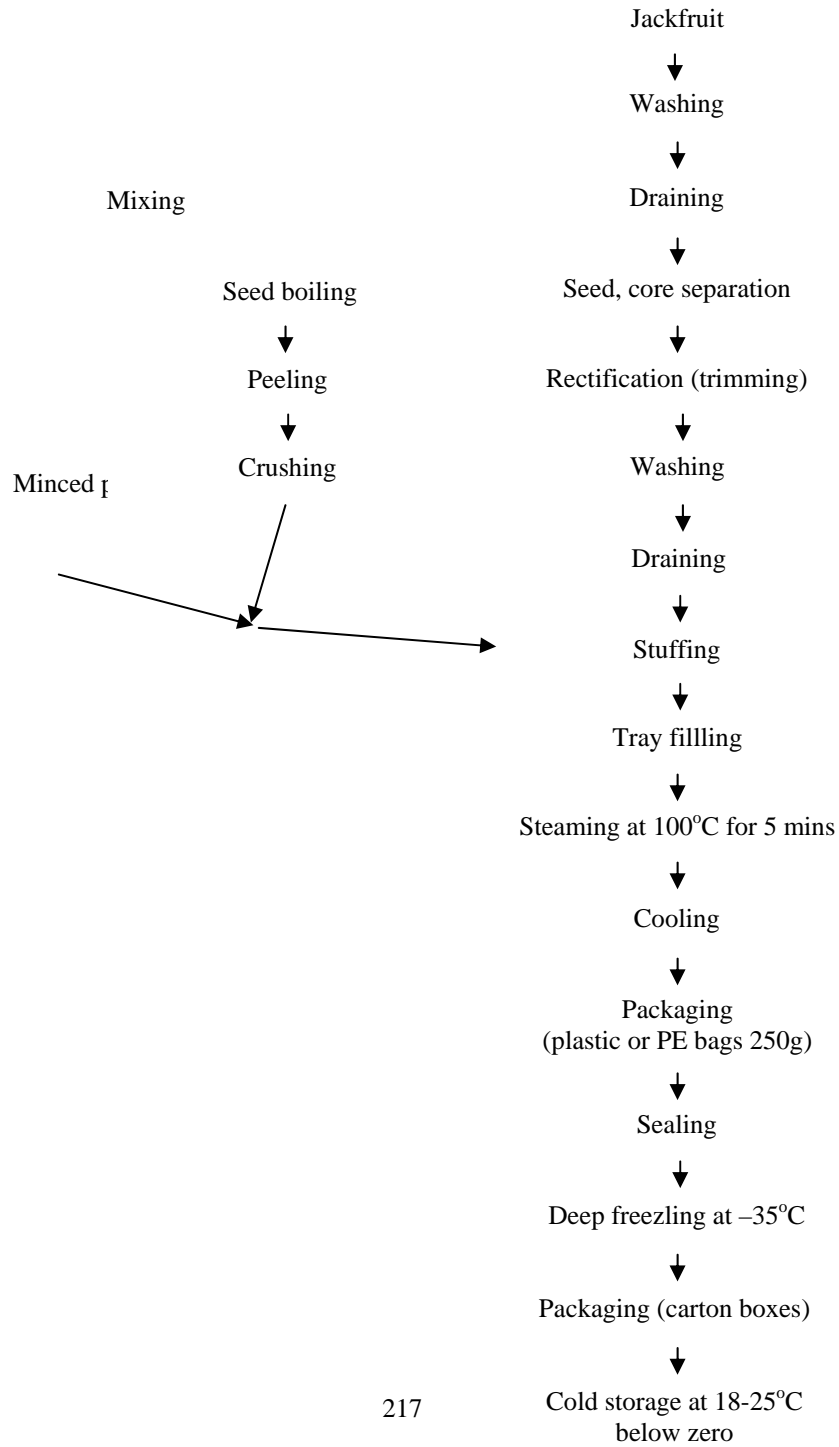
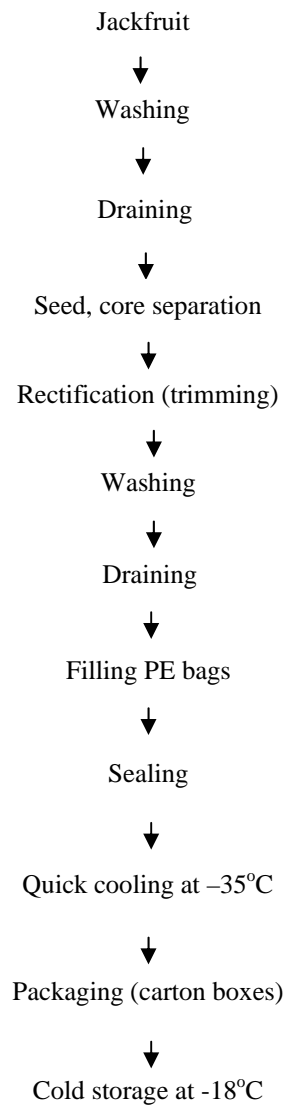


Figure 2 Processing flow-sheet for frozen jackfruit



Mangosteen

Introduction

Mangosteen (*Garcinia mangostana*) is cultivated throughout the Asian tropics and other tropics of the World, such as Malaysia, Thailand, Indonesia, Vietnam, Sri Lanka, India, Burma, China and Philippines. It is a sweet, soft and delicious fruit of the tropics with an exciting flavour. This subglobose fruit 3.5-8 cm in diameter has a dark purple, thick rind (the pericarp) containing the white edible part (the endocarp in segments) inside. The rind is also characterised by persistent sepals in the stem end and 4-8 stigmatic lobes on the flower-end of the ripe fruit. The number of stigmatic lobes indicates the number of internal segments.

Mangosteen trees begin to set fruit in 8-10 years depending on the location, care and vigor of the tree. It flowers from February-May and the fruits ripen from May-September. The quality of the fruits is as superior as those produced in Malaysia and Thailand. The fruits weigh 75-150g with the edible part 30-31% of the total fruit weight. Thank to the special taste, Mangosteen is considered to be as "Queen of Fruits".

In Vietnam, mangosteen can grow and develop well only in the Mekong River Delta (Southern Vietnam). The total area under cultivation is 2,150 ha with annual production 6,500 tons. Ben Tre and Binh Duong provinces are the two main mangosteen production regions of Vietnam.

Soil and climate requirements

Mangosteen trees can adapt to different kinds of soils (from hilly red soils mixed with gravels to sandy loam in the plains), but they grow better in deep clay loam or silt loam with good drainage. The soil with pH 5-5.7 is most suitable for mangosteen growth. The land with altitude higher than 500m is not suitable for mangosteen growth.

As a typical tropical fruit tree, mangosteen requires a tropical climate with high humidity, high temperature (more than 20°C) and abundant rainfall as well as shady environment, especially during the early stage of growth.

Composition and uses

Mangosteen fruit is a rich source of vitamins, carbonhydrates and minerals, particularly calcium and phosphorus. The fruit hulls of mangosteen are reported to be used as an astringent and also used against cholera, dysentery and diarrhoea.

The fruit contains 79% water, 0.5% protein, 20% carbohydrates, 0.63% acidity (citric acid), 0.3% fibre, 11 mg% calcium, 17 mg% phosphorus, 0.09mg% vitamin B (thiamin), 0.06mg% vitamin B2 (riboflavin), 0.1 mg% vitamin B5 (niacin), 66 mg% vitamin C (ascorbic acid).

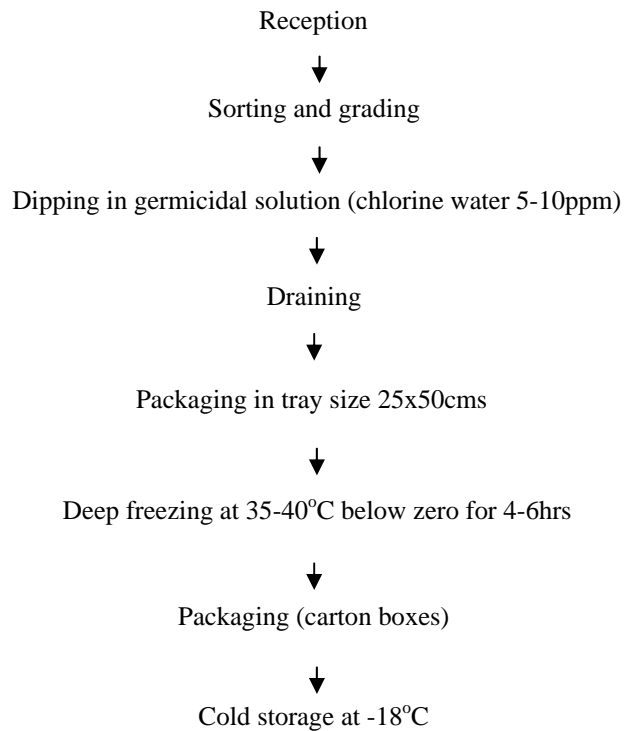
Mangosteen is used mainly as a fresh fruit or topping for ice-cream. The fresh fruits can be stored for several weeks (6-7 weeks) under refrigeration (4-7°C) and 85-90% RH. At room temperature (25-30°C) the fruit can be stored for 5-7 days. The fruit has medicinal value to strengthen the appetite and to cure indigestion.

Storage and processing of mangosteen

Mangosteen can be stored for 2-3 weeks at room temperature, and the shelf life can be increased for about a month by storing them at 9-12°C. The optimum storage conditions for the mangosteen are 4-6°C with 85-90% RH to obtain a maximum shelf life up to 49 days. The soluble solids, total acidity, and ascorbic acid content of the fruit decreased, and the reducing sugar increased during storage. The hardness of the fruits also increased, particularly at storage temperature less than 4°C. The aroma and flavour are quite stable during the low temperature storage.

Mangosteen is used mainly as a fresh fruit. It can also be processed into stable products such as juice, jelly, squash, canned fruit segments and frozen mangosteen. Freezing of mangosteen is considered to be advantageous.

Figure 3 Flowchart for freezing of mangosteen



Pummelo

General introduction

Pummelo (*Citrus grandis*) originated from southern China and neighbouring countries including Vietnam. The fruits are large but subglobose in shape. Rind surface and fruit flesh are white or yellowish in colour. Fruit are highly juicy, sweet with bitter aftertaste.

Total area under pummelo cultivation in Vietnam is 8,170ha (from which 5,000ha bear fruit) with annual production 50,000 tons of pummelo. Ha Tinh, Vinh Long, Dong Nai, Binh Duong, Hue, Phu Tho provinces and Hanoi are the main pummelo production of Vietnam with famous pummelo varieties such as “Phuc Trach”, “Nam Roi”, “Thanh Tra”, “Doan Hung”, “Dien” etc.

Composition and use

Fruit of pummelo weighs 900-1,200g, of which the edible part (flesh) 50-55%. The flesh contains 90% water, 11-14% total soluble solids, acidity 1.5-1.7%, ascorbic acid (Vitamin C) 70-120mg%. The rind of pummelo is rich in pectin (3.8-7%) and serves as a good source for pectin production. Pummelo is used mainly as fresh fruit. It can also be processed into some products such as juice and squash.

Table 3 Composition of some main pummelo varieties of Vietnam

Varieties	TSS %	Total sugar %	Pectin %	Vitamin C %	Carotene mg%
Doan Hung	13	11.3	0.14	118	0.14
Phuc Trach	11	6.6	0.12	92	0.10
Thanh Ha	14	11.7	0.27	77	0.13
Bien Hoa	11	6.2	0.45	105	0.12

Processing of pummelo

Pummelo is used mainly fresh. However it can be processed into pummelo juice. The rind of pummelo is a good source for extraction of industrial pectin.

Figure 4 Processing flowchart for pummelo juice

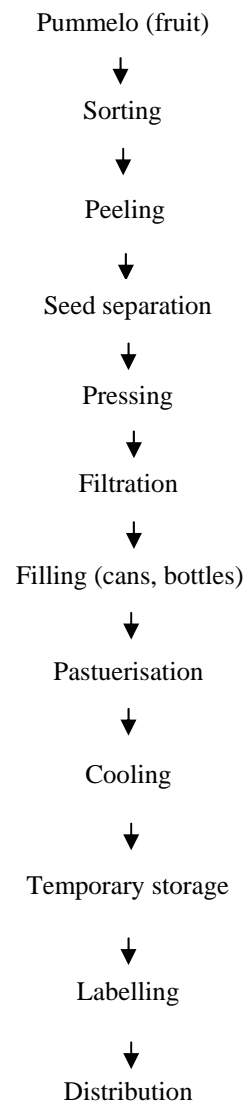
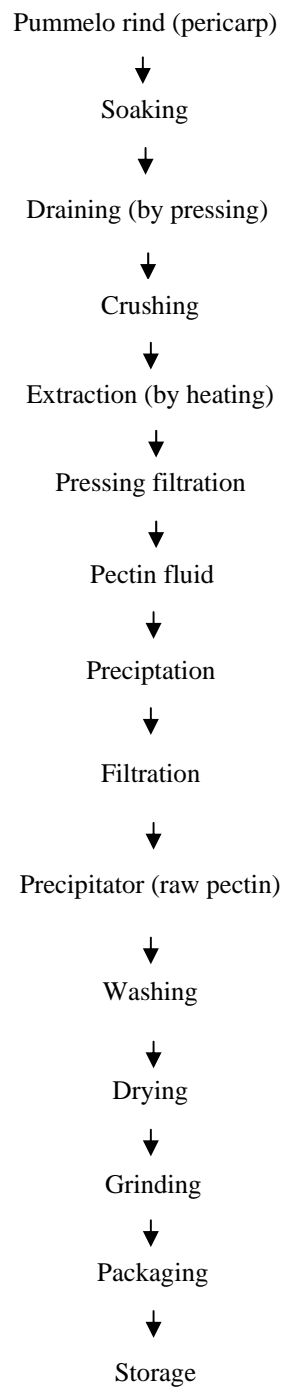


Figure 5 Processing flowchart for pectin extraction from pummelo rind



MARKETING OF UNDERUTILISED TROPICAL FRUITS

In comparison with others fruits, recent production of underutilised fruits of Vietnam makes up less than 3% of total fruit crop production. Underutilised fruit production is self-production and self-consumption. The fruits are mainly used for local consumption. Some fruits of good varieties and high quality have been consumed throughout the country. Only a little part of them has been exported to China, Taiwan, Japan, Russia (mangosteen, pummelo). Local consumption market and potential export market for underutilised fruits of Vietnam are shown in the tables below.

Table 4 Local consumption market of underutilised fruits of Vietnam

No	Region	Pummelo	Jackfruit	Mangosteen
1	Red river delta	Hanoi, Ha Tay	Hanoi, Hoa Binh	Hanoi
2.	North East	Phu Tho, Bac Kan	Phu Tho, Bac Giang	-
3.	North West	Cao Bang, Lang Son	Thai Nguyen, Lang Son	-
4.	North Central	Ha Tinh, Quang Binh	Thanh Hoa, Nghe An	Hue
5.	South Central	Bien Hoa, Quang Ngai	Quang Nam, Quang Ngai	Bien Hoa
6.	Central Highland	Buon Me Thuot	Lam Dong	-
7.	South	Cuu Long, Can Tho	Hau Giang	Ben Tre
8.	Mekong river delta	Binh Duong, Vinh Long	Binh Phuoc	Tien Giang

Table 5 Potential export market of underutilised fruits of Vietnam

No	Kind of fruits	Importer
1.	Pummelo	Laos, Thailand, Cambodia
2.	Jackfruit (To Nu variety)	Thailand, Laos, China, Hong Kong
3.	mangosteen	China, Hong Kong.

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