



Regional Expert Consultation on

Underutilized Crops for Food and Nutritional Security in Asia and the Pacific

Proceedings and Recommendations

November 13-15, 2017; Bangkok, Thailand

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Cover page photo identity

First column

Amarnath
Buckwheat
Finger millet
Java plum (*Jamun*)
Winged bean
Syrian rhubarb
Seabuckthorn

Second column

Moringa
Rice bean
Kodo millet

Third column

Field view of Foxtail millet (Top)
Faba bean, Rose apple and Quinoa (Bottom)

APAARI acknowledges the contributions of authors of articles and reports for the selected photos used on front cover page

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Contents

Foreword	iii
Acknowledgements	iv
The Organizers.....	v
Acronyms and Abbreviations	vii
Executive Summary	1
Background of the Expert Consultation	4
Objectives	6
Opening Session	7
Technical Session I: Thematic Technical Presentations	10
Technical Session II: Strategies on Underutilized Crops for Food and Nutritional Security	13
Technical Session III: Country Status Reports on Underutilized Crops	15
Special Session: Women Farmers as Driving Force	19
Technical Session IV: Working Groups Discussion	20
Technical Session V: Panel Discussion on Policy Support for Underutilized Crops to Achieve SDGs	23
Plenary Session	26
Major Recommendations	28
Appendix I Participants	32
Appendix II Inaugural Address	41
Appendix III Technical Programme	47
Appendix IV Organizing Committee	52
Appendix V Photo Gallery	53

Foreword

In the post-green revolution era we are still struggling to provide income, food, health, nutrition and environmental security to a large part of the population. The fact is recognized globally and hence Zero Hunger and Good Health and Well Being are prioritized next only to No Poverty among the 17 Sustainable Development Goals (SDGs). In 2016 the number of chronically undernourished people in the world is estimated to have increased to 815 million, up from 777 million in 2015. Absolute number (c. 520 million) of undernourished people is largest in Asia. Many Pacific Island countries and territories are showing much higher adult obesity rates (in the range of 40-50%) than those of other countries with a similar prevalence of undernourishment.

In order to address the issue of hunger and malnutrition through nutrient rich and climate resilient underutilized crops, the Asia-Pacific Association of Agricultural Research Institutions (APAARI), a unique voluntary, membership-based, self-mandated, apolitical and multi-stakeholder (70 members) organization in the Asia-Pacific region planned a multi-stakeholder "Regional Expert Consultation on Underutilized Crops for Food and Nutrition Security in Asia and the Pacific". The major aim of APAARI is to help realizing SDGs in Asia and the Pacific to act together to end hunger and prevent all forms of malnutrition by 2030.

This Regional Expert Consultation was organized by APAARI (under its programme on Asia-Pacific Consortium on Biotechnology and Bioresources; APCoAB) and the Council of Agriculture (COA), Taiwan, in collaboration with Bioversity International, Crops for Future, Department of Agriculture, Thailand, International Centre for Agricultural Research in the Dry Areas, International Crops Research Institute for the Semi-Arid Tropics and World Vegetable Centre during November 13-15, 2017 at Bangkok, Thailand. It was aimed (i) to create awareness on the role and value of underutilized crops which have potential for diversification of food basket to ensure better food and nutritional security in Asia-Pacific region; (ii) to share experiences to accelerate the use of underutilized plants as crops for future and (iii) to assess R&D status on priority crops, and policies that are needed to promote the use of these potential crops for future use in Asia and the Pacific.

A total of 54 participants from 18 countries deliberated on the above issues. The participants comprised senior officials, researchers, experts on underutilized crops from public and private sector including a farmer. The meeting was structured to include inaugural, technical, special and plenary sessions with 9 speakers on themes, 6 speakers on strategies, 16 country reports, four working groups and a panel discussion. Some of the major recommendations that emerged from the consultation on research and education are mapping genetic resources, documentation and validation of ITK, enhanced research and bio-prospecting for better varieties and products, funding source for human capital development. In the area of developmental activities, facilitation of value chain enhancement from seed to marketing products, addressing supply chain issues, promoting custodian farmers, creating awareness and increasing investment opportunities. Policy issues highlighted during the consultation are to promote cultivation and food subsidies at government level to address malnutrition, forming apex committees to prioritize and monitor research and developmental activities at national level in countries with acute problem of food, nutrition, income and environment insecurity to use the approach of neglected and underutilized crop species for cultivation and use.

Deliberations of Expert Consultation are being published in two parts: the first being "Proceedings and Recommendations" and the second on "Thematic, Strategic and Country Status Reports on Underutilized Crops of Asia-Pacific Region" for use more as ready reference. I am sure the content of Proceedings and Recommendations that include crisp summary of presentations and discussions followed by major recommendations and action plan will be extremely useful to all stakeholders including APAARI for implementation.

I sincerely hope that implementation of these action plans will address SDGs 2, 3 and 13 in the region. APAARI is committed to take the agenda forward.

Ravi Khetarpal

Executive Secretary, APAARI

Co-Chair, Organizing Committee

Acknowledgements

The organization of this multi-country, multi-institutional and multi-stakeholder Expert Consultation has been an exciting as well as challenging opportunity, considering the several issues that had to be planned and managed. On behalf of APAARI, APCoAB and my own behalf, I would like first to thank the Co-Organizer, Council of Agriculture (COA), Taiwan and Co-sponsors - World Vegetable Centre (WorldVeg), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Crops for Future (CFF), International Centre for Agricultural Research in the Dry Areas (ICARDA), Bioversity International and Department of Agriculture (DOA), Thailand, for their whole-hearted support, including generous financial contributions, for organizing the Expert Consultation.

Whilst organizational support was important, strategic and technical input of individuals was also very critical. We place on record, our immense gratitude to Dr Raj Paroda, Chairman, TAAS and Senior Advisor, APAARI, who conceptualized the organization of Regional Expert Consultation on Underutilized Crops for Nutrition and Food Security in Asia and the Pacific, and significantly contributed to develop an effective technical programme and guided in various ways. Dr Yusuf Zafar, Chairman, APAARI, is sincerely thanked for enormous support and encouragement during preparation and organization of the Expert Consultation. Thanks are due to Dr Ravi Khetarpal, Executive Secretary, APAARI, for critical guidance and constant support in not only this Expert Consultation but in other activities of APCoAB. Sincere appreciation is accorded to Dr Bhag Mal, Ex-Interim Secretary, APAARI and Dr Umesh Srivastava, Ex-ICAR, for drafting the Concept Note of this Expert Consultation. Dr Hiroyuki Konuma, (Former ADG, FAO RAP) Professor and the Director, ASEAN Centre, Meiji University, Bangkok, Thailand, is thanked profusely for delivering a very informative and scintillating inaugural speech, which set the tone of the deliberations for the participants.

Most grateful thanks are extended to all the Co-Chairs for conducting the respective sessions efficiently and steering the discussions, which resulted in important and useful recommendations presented in this document. All the speakers and panelists of various technical sessions and panel discussion are immensely thanked for their excellent contributions and participants/discussants for their insightful interventions. Thanks are also due to the Heads and/or their representatives of NARS of member countries, who prepared and presented the country status reports on underutilized crops, which will be useful to analyze the information for developing road map at national, sub-regional and regional levels. All the Rapporteurs and Facilitators of technical and plenary sessions, working groups and panel discussions are acknowledged for meticulously capturing the salient points that emerged from the presentations/discussion and also for drafting the recommendations.

As far as the organizing committee is concerned, sincere appreciation is extended to all staff members of APAARI Secretariat, namely, Mr Vishwanath K. Sah, Ms Thansita Tanaphatrujira, Ms Celilu Bitong and Ms Tarathip Sanboonbrong for their concerted, untiring efforts and invaluable contributions in the preparatory phase as well as during the event. They have worked constantly behind the scene to manage with all financial, logistic and administrative aspects in organization of the Expert Consultation.

Sincere thanks are accorded to all the Co-editors, especially Drs K.S. Varaprasad, Anjula Pandey and Anuradha Agrawal, for their intensive involvement in collation, compilation and critical editing in order to give shape to the proceedings in the present form.

I hope that the recommendations presented in this document will draw attention of the policy makers, administrators, researchers, farmers and other stakeholders towards promoting the cultivation of underutilized crops in Asia-Pacific region.

Rishi Tyagi

Coordinator, APCoAB

Co-Chair, Organizing Committee

The Organizers



The Asia-Pacific Association of Agricultural Research Institutions (APAARI)

The Asia-Pacific Association of Agricultural Research Institutions (APAARI), with its headquarters in Bangkok, is a unique voluntary, membership-based, self-mandated, apolitical and multi-stakeholder regional organization in the Asia-Pacific region. It promotes and strengthens agriculture and agri-food research and innovation systems through partnerships and collaboration, capacity development and advocacy for sustainable agricultural development in the region. Since its establishment in 1990, APAARI has significantly contributed towards addressing agricultural research needs and enhancing food and nutritional security in the region. The close links, networks, partnerships and collaboration with stakeholders that APAARI has developed over the years, as well as its goodwill, authority and focus on results, make the Association an important actor in the region. The ultimate aim of APAARI is to help realising sustainable development goals in Asia and the Pacific. For more details, please visit: <http://www.apaari.org>



Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB)

The Asia-Pacific Consortium on Agricultural Biotechnology was established in 2003 under the umbrella of APAARI. Later in 2017, it was renamed as Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB). APCoAB has the mission to harness the benefits of agricultural biotechnology bioresources for human and animal welfare through the application of latest scientific technologies while safeguarding the environment for the advancement of society in the Asia-Pacific region. For more information, please visit: <http://www.apcoab.org>; <http://www.apaari.org/web/our-projects/apcoab/>



Council of Agriculture Research (COA)

The Council of Agriculture (COA), Taiwan is the competent authority on the agricultural, forestry, fishery, animal husbandary and food affairs in Taiwan. Its responsibilities include guiding and supervising provincial and municipal offices in these areas. Under the council, there are Department of Planning, Department of Animal Industry, Department of Farmers' Services, Department of International Affairs, Department of Science and Technology, Department of Irrigation and Engineering, Secretariat, Personnel Office, Accounting Office, Civil Service Ethics Office, Legal Affairs Committee, Petitions and Appeals Committee and Information Management Center respectively in-charge of related affairs. For more information, please visit: <http://eng.coa.gov.tw>



World Vegetable Center The World Vegetable Center

The World Vegetable Center, an international non-profit research and development institute, is committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of nutritious and health promoting vegetables. From its founding mandate in 1971 to support vegetable research and development in tropical Asia, AVRDC - The World Vegetable Center has expanded its focus to serve more continents, more countries, and more people. Today, Center researchers lead and participate in projects throughout Asia, Africa, Central America, and Oceania. We have 300 staff engaged in this spread of activities, and seek to partner with governments, nongovernmental organizations, universities, research institutes, and the private sector to promote prosperity for the poor and health for all. For more information, please visit: <https://avrdc.org/>



ICRISAT

The International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics are home to over 2 billion people, and 644 million of these are the poorest of the poor. ICRISAT and its partners help empower these poor people to overcome poverty, hunger and a degraded

environment through better agriculture. ICRISAT is headquartered near Hyderabad, Telangana State, India, with two regional hubs and four country offices in sub-Saharan Africa. It belongs to the Consortium of Centers supported by the Consultative Group on International Agricultural Research (CGIAR). For more information, please visit: www.icrisat.org/



Since its inception, Crops For the Future (CFF) has established partnerships with organizations around the world to improve food and nutrition security, health and incomes of the poor, and the sustainable management of fragile ecosystems. Crops For the Future Research Centre (CFFRC) was established in 2011 to provide research support for the global Crops For the Future organisation. CFFRC is a company limited by guarantee and without share capital. Its guarantors are the Government of Malaysia and the University of Nottingham in Malaysia.

In 2014, Crops For the Future and CFFRC combined their resources to form a single global entity - CFF. CFF now combines its research and development functions on underutilized crops (CFF Research) with Future Crop, an educational resource for underutilised crops and agricultural biodiversity. Both CFF Research and FutureCrop will increasingly offer consultancy services to interested parties. For more information, please visit: www.cffresearch.org/



The International Center for Agricultural Research in the Dry Areas (ICARDA) is a global research-for-development organization. With a vision of thriving and resilient livelihoods in dryland communities of the developing world coming with robust incomes, secure access to food, markets, nutrition and health and the capacity to manage natural resources in equitable, sustainable and innovative ways. Since its establishment in 1977 as a non-for-profit organization, ICARDA has implemented research for development programs in more than 50 countries in the world's dry areas, spanning from Morocco in North Africa to Bangladesh in South Asia.

ICARDA combines scientific evidence and indigenous knowledge from dryland communities to address these challenges, which also have a considerable impact on emerging global issues of food security, land degradation and climate change. Our research aims to provide the evidence required to better position dryland issues firmly on the research and development agenda at national, regional and global levels. For more information, please visit: <http://www.icarda.org/>



Bioversity International is a global research-for-development organization. We have a vision – that agricultural biodiversity nourishes people and sustains the planet. We deliver scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity to attain sustainable global food and nutrition security. We work with partners in low-income countries in different regions where agricultural and tree biodiversity can contribute to improved nutrition, resilience, productivity and climate change adaptation. For more information, please visit the website: <https://www.bioversityinternational.org/>



Department of Agriculture (DOA)

The Department of Agriculture (DOA) was established since October 1, 1972 under the Revolutionary Decree No. 216 dated September 29, 1972 by merging the former Department of Agriculture and the Rice Department. The union was aimed to facilitate coordination among the Departments and officers as well as to streamline its function to enable a more efficient implementation of its mandates. The 15 pioneering units of the Department of Agriculture were the Office of the Secretary, Finance Division, Personnel Division, Planning Division, Rice Division, Field Crops Division, Horticulture Division, Sericulture Division, Rubber Division, Agricultural Engineering Division, Plant Pathology Division, Entomology and Zoology Division, and Agricultural Chemistry Division, a total of 95 research centres, stations and plant quarantine stations were then established throughout the country. For more information, please visit: www.doa.go.th/en/

Acronyms and Abbreviations

ABS	Access and Benefit Sharing
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AICRN	All India Coordinated Research Network
AICRP	All India Coordinated Research Project
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources
APR	Asia-Pacific Region
AREEO	Agricultural Research, Education and Extension Organization
AR4D	Agricultural Research for Development
ASEAN	Association of Southeast Asian Nations
BARC	Bangladesh Agricultural Research Council
CABI	Centre for Agriculture and Biosciences International
CePACT	The Centre for Pacific Crops and Trees
CFF	Crops For the Future
CFFRC	Crops For the Future Research Centre
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research (in short CG)
COA	Council of Agricultural Research
COE	Centre of Excellence
CSKHPKV	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya
CWR	Crop wild relative
DDG	Deputy Director General
DOA	Department of Agriculture
FAO	Food and Agriculture Organization
FAO RAP	Food and Agriculture Organization of the United Nations - Regional Office for Asia and the Pacific
FARM	Forecast Application in Risk Management
FRIM	Forest Research Institute Malaysia
GAPAD	Global Action Plan for Agricultural Diversification
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFAR	Global Forum on Agricultural Research and Innovation
GODAN	Global Open Data for Agriculture and Nutrition Action
HERS	Heroines for Environment and Rural Support
IAEA	International Atomic Energy Agency
IARC	International Agricultural Research Center
IARI	Indian Agricultural Research Institute
ICAC	International Cotton Advisory Committee
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICGEB	International Center of Genetic Engineering and Biotechnology
ICIMOD	International Centre for Integrated Mountain Development
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics

IFAD	International Fund for Agricultural Development
IGZ	Leibniz-Institute für Gemüse- und Zierpflanzenbau
IIOR	Indian Institute of Oilseeds Research
IPCC	Intergovernmental Panel on Climate Change
IPGRI	International Plant Genetic Resources Institute
IRRI	International Rice Research Institute
IT	Information Technology
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
JOCV	Japan Overseas Cooperation Volunteers
KM	Knowledge Management
MAF	Ministry of Agriculture and Fisheries
MARDI	Malaysian Agricultural Research and Development Institute
MDGs	Millennium Development Goals
MOA	Ministry of Agriculture
MOOC	Massive Open Online Course
MTA	Material Transfer Agreement
NAAS	National Academy of Agricultural Sciences
NAFRI	National Agriculture and Forestry Research Institute
NARC	Nepal Agricultural Research Council
NARI	National Agricultural Research Institute
NARS	National Agricultural Research System
NBPGR	National Bureau of Plant Genetic Resources
NGO	Non-Government Organization
NIAB	Nuclear Institute for Agriculture and Biology
NPGR	National Plant Genetic Resources Center
NPO	Non-Profit Organization
NUS	Neglected or Underutilized Species
ODAP	β -N-Oxalyl-L α,β diaminopropionic acid
PAEC	Pakistan Atomic Energy Commission
PARC	Pakistan Agricultural Research Council
PAU	Punjab Agricultural University
PCAARRD	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development
PDS	Public Distribution System
PGR	Plant Genetic Resources
PMO	Project Management Officer
PNG	Papua New Guinea
PPP	Public-Private Partnership
RAP	Regional Office for Asia and the Pacific
R&D	Research and Development
RIMES	Regional Integrated Multi-hazard Early Warning System
SDGs	Sustainable Development Goals
SESAME	Specialized Expert System for Agro-Meteorological Early Warning for Climate Resilient Agriculture
SIDS	Small Island Developing States
SLCARP	Sri Lanka Council for Agricultural Research Policy

SPC	Secretariat of the Pacific Community
TAAS	Trust for Advancement of Agricultural Sciences
TARI	Taiwan Agricultural Research Institute
TCAP	Technical Cooperation – Asia & Pacific
TLB	Taro Leaf Blight
UNDP	United Nations Development Programme
UNM	University of Nottingham Malaysia Campus
UNEP	United Nations Environment Programme
UUC	Underutilized crops
UUP	Underutilized Plant
VAAS	Vietnam Academy of Agricultural Sciences
WHO	World Health Organization
WorldVeg	World Vegetable Center

Executive Summary

A multi-stakeholder “**Regional Expert Consultation on Underutilized Crops for Food and Nutritional Security in Asia and the Pacific**” was organized at Rama Garden Hotel, Bangkok, Thailand, from November 13-15, 2017. The meeting was organized by APAARI/APCoAB, Bangkok, Thailand and COA, Taiwan, in collaboration with World Vegetable Centre, ICRISAT, CFF, ICARDA, Bioversity International and DOA, Thailand. The objective was to create awareness on the role and value of underutilized bioresources (UUC/NUS/CFF/UUP/minor crops/orphan crops; for all these terms, more often than not, hereafterward word abbreviated as UUC in present document), to share experiences, assess R&D status on priority crops and develop policies to promote these crops for the future. A total of 54 participants from 18 countries comprising senior officials, researchers from NARS and CG centres, experts on UUCs, research administrators, NGOs and a farmer participated in the 3-day deliberations (Appendix I).

In the **Opening Session**, Dr Hiroyuki Konuma delivered inaugural address (Appendix II). The context of the Expert consultation was set by seven expert speakers. There was consensus on the opinion that impact of climate change would adversely effect achieving food and nutrition security as envisaged under the SDGs (Zero Hunger, Good Health and Well-being). The potential of UUCs is tremendous to overcome this, as they have greater resilience to biotic and abiotic stresses. However, they require R&D efforts and support to enhance production for the benefit of consumers as well as farmers. Participation of private sector, consumer awareness and value chain development are important and need to be discussed in this context. It was urged that the Expert Consultation should also discuss partnership avenues and networking opportunities, to identify policy options and strategic actions to promote UUCs in the APR, by sharing experiences and taking stock of R&D achievements and gaps for the UUCs. It was concluded after the three days deliberations, that a clear roadmap would be developed for a strong partnership and networking of stakeholders from APR for greater research, pre-breeding, policy and funding support for UUCs.

The **Technical Session I** on Thematic Papers comprised nine presentations from six countries with the objectives to cover various categories, diversity, use and management strategies of UUCs. Competent global experts dealt comprehensively on various themes like global scenario of UUCs, agriculture diversification with crops for the future in APR, grass pea (a neglected pulse), nutritionally rich underutilized vegetables, edible wild plant diversity, bio-fortification of underutilized food staples and a case study of production risk management in fragile ecosystems. Strategies to mainstream UUCs, by detailing the leverage points of each level within the food supply chain were discussed. Development of a Global Knowledge Base for UUCs, comprising databases and apps, for diversification of agriculture were discussed. ‘SNAP’ program, acronym for Sustainable Living, Nutritious Diets and Partnerships by CFF to develop healthier students in peri-urban settings were discussed in the context of collaborations to promote the crops for the future. Success stories in crops like oil palm, soybean, kiwi, and the role of consumer awareness and networking for promotion of these crops was discussed. Importance of food science was discussed for better adoptability by consumers with value addition considering modern lifestyle. Based on comparative studies on region-specific consumption of traditional vegetables, re-introduction of phytonutrient rich traditional vegetables for healthier diets was recommended. Urgent need to document, sustainably use, breed and share not only the useful wild and edible plants from tribal regions, but also their indigenous technical knowledge, was emphasized. Possibilities of developing bio-fortified varieties in UUCs was discussed. It was also opined that seed systems for UUCs should be in place on priority along with production, processing and value chain with a view to tag the value for consumer. It was opined that policy-based interventions like subsidies and promotion through government food schemes would significantly promote UUCs.

In **Technical Session II**, strategies were discussed to cover specific crops/crop groups of UUCs in the six presentations. These included pseudocereals (grain amaranth, buckwheat and chenopods), small millets (finger millet, foxtail millet, proso millet, kodo millet and barnyard millet), underutilized grain legumes (rice bean, moth bean, adzuki bean, faba bean and horse gram), tuber crops (taro, cassava, sweet potato, yams, potatoes), minor fruits (jackfruit, custard apple, jewish plum, ber and tamarind) and seabuckthorn.

It emerged that promotion of these crops requires a participatory approach, application of scientific tools and techniques, education and training to improve rural health and economies. Resurvey and documenting of diversity, conservation, ethnobotanical aspects, local food recipes, food and nutritional value, promoting custodian farmers approach, sustainable utilization, developing value chain and market support are other important aspects. Mutation breeding could possibly be used for improvement UUCs wherever feasible. An urgent need was opined for mapping UUCs in the APR, in terms of both genetic resources and expertise.

Technical Session III comprised Country Status Reports and was divided into three groups to include country reports from South Asia, South East Asia and the Pacific Countries. From the reports it was clear that countries in the APR had varied capacities in conducting R&D and managing genetic resources of UUCs from very strong to very weak. Based on existing systems, countries called for strengthening of conservation facilities, documentation, value addition, marketing and capacity building, by facilitation through current Regional Consultation. Other lacunae identified for promoting UUCs were evolving varieties for specific end-uses and increased health benefits, development of cost-effective processing technology, improvement of shelf life, issues of supply chain and thrust on marketing. For sustainable agricultural system and promotion of UUCs, priority areas included documentation, linkages and collaboration, prioritization in policy, awareness generation, value addition and product development supporting local food chains and establishing local processing industries and linking with marketing, eco-tourism, organic trades, hospitals and school feeding programs. Some of these challenges could be addressed through international networking.

A **Special Session** was organized on 'Women Farmers as Driving Force' where Eri Otsu, an activist, a mother and a farmer from Japan, presented her success story in raising the voices of rural women and farmers. She advocated not only empowerment of women farmers, but also spoke about her programs on establishment of renewable energy supply system, educating children about agriculture, archiving local wisdom and techniques related to agriculture and food, promoting agricultural tourism and networking through seminars, workshops, meetings, to exchange ideas.

The **Technical Session IV** comprised four **Working Groups** to brainstorm on four thematic areas, and experts were asked to join the groups of their interest. The themes comprised (i) production and crop improvement, (ii) value addition and marketing, (iii) partnership and capacity building and (iv) biotechnology for enhancing utilization. The Working Group 1 recommended that greater efforts be placed in all aspects of germplasm management, agronomy, seed production systems of UUCs and APAARI should help in Knowledge management (KM) and dissemination. The Working Group 2 subscribed to prioritization of crops at national level for utilization, considering the vast number of UUCs existing, development of pro-poor value chains, market intelligence and strategies and policy intervention of PDS, mid-day meal, school menu, moving markets, etc. In the Working Group 3, it was unanimously agreed that strong partnership between IARCs, NARS, Universities, Regional Networks, NGOs, NPOs, Scientific Societies, Farmers Groups was required to strengthen work on UUCs and also Policy Advocacy and Networking to promote UUCs. The Working Group 4 unanimously acknowledged the advantages of application of biotechnological tools in crop improvement, germplasm management and production of quality planting material of UUCs. The specific biotechnological requirements of South Asia, South East Asia and Pacific Countries for UUCs of millets, tubers, pulses and fruits were also chalked out.

The **Technical Session V** was a **Panel Discussion** about the kind of policy support required at national and regional levels to facilitate the requisite support required by various stakeholders in promoting UUCs to achieve better food, nutrition and health security as envisaged under the SDGs. Ten panelists from eight countries provided their perception on this theme. There was consensus that an agreeable definition of UUCs needs to be developed. APAARI should facilitate development of a comprehensive database, which should include sources of material, nutritional advantage, list of experts and gaps with respect to UUCs. Competitive international funding be made available for R&D in UUCs. It was opined that free exchange of germplasm between countries was a win-win situation. There was need to popularize UUCs. Actions may include promotion of recipes with UUCs, inclusion in school feeding programs, awareness

generation through pop stars, *etc.* While the youth are not attracted to agriculture in general, novel types of crops and products in conjunction with new forms of communication may act as an incentive. Convincing funding agencies to support work in these crops or species is difficult and requires resetting of priorities. APAARI may help in this regard by developing a network to tap expertise in CG centers, NARS and Universities. Government support to both public and private sectors is required to enhance technology. For this consortia like Steering Committee, Working Groups, Crop Groups should be encouraged. It was also subscribed to increase institutional and public awareness about UUCs. Research on UUCs is required to increase productivity and profitability. For this, country NARS should identify most potential UUCs in their respective countries and give greater thrust on research and innovations for development of these crops with enhanced funding and development of human resources. Farmers need to be connected to the market and youth can be attracted by making UUCs profitable. UUCs should be promoted at 'nutricrops' that could address the SDG 3 target of nutritional security.

During the **Plenary Session**, it was unanimously agreed that UUCs will have greater impact on agricultural landscape in the wake of climate change, as a wide arrays of crops can be chosen to meet the nutritional requirement. All agreed that organization of the Expert Consultation by APAARI was very appropriate and timely. As APAARI works in collaboration with NARS of member countries, it should harness maximum synergies through partnership and networking in promoting R&D in these crops. The proceedings of this meeting should be shared and discussed in all appropriate fora, especially those addressing the strategies to meet the SDGs.

Background of the Expert Consultation

Despite Green, White and Blue Revolutions, poverty and hunger are still the twin challenges being faced globally. Eradication of extreme poverty and hunger has been a target in every major development program of the United Nations, including the Agenda 21 during the Earth Summit (1992) and Millennium Development Goals (MDGs) during Millennium Summit (2000). Yet, according to FAO estimates, around 795 million people were living below poverty line in 2014-2015, mostly in the developing countries, with maximum concentration in South Asia and Sub-Saharan Africa. Besides poverty, the Asia-Pacific region faces major challenge of hunger and malnutrition (including micronutrients deficiency) vital for development, disease prevention, and well-being. Micronutrients are not produced in the body and must be derived from the diet. Thus, besides household food security, nutritional security is equally important.

To continue the global collective actions more vigorously, heads of nations met and jointly adopted a renewed set of goals to end poverty, protect the planet and ensure prosperity for all as part of new SDGs. The resolution adopted by the United Nations, in September 2015, acts as the post-2015 Development Agenda. There are 17 aspirational "Global Goals" with 169 targets under SDGs. Among these, there are three goals which have direct relevance to agriculture. These are: 'No Poverty', 'Zero Hunger', and 'Climate Action'. In addition, the one on 'Life on Land' is indirectly related. The three main objectives of food, nutrition and health care are to be addressed by each nation to achieve the SDGs at a faster pace. At least 12 of the 17 SDGs contain indicators that are highly relevant for nutrition, reflecting nutrition's central role in sustainable development. In this context, agriculture assumes major role and is an important sector to help achieve the SDGs. At the same time, agriculture is currently facing numerous challenges, such as decline in the size of land holdings and natural resources (especially soil and water), adverse impact of climate change, productivity decline, rise in cost of inputs, fluctuating markets, and decline in farmers' income. Hence, they all make agriculture a risky proposition requiring diversification, sustainability and resilience through good agronomic practices.

Currently, global food security is largely dependent on a handful number of crops. Over 60% of the global requirement for proteins and calories are met by just three crops - rice, wheat and maize. This is a paradox, considering that in human history, 40-100,000 plant species have been reportedly used for food, fibre, industrial, cultural and medicinal purposes, including 30,000 species of edible plants in wild, semi-domesticated or fully cultivated forms. Although some 7,000 cultivated species are in use today around the world, yet fewer than 30 species provide 90% of global food demand. In contrast, there are hundreds of species known by different names such as 'lesser known species', 'neglected crops', 'underutilized crops', 'marginal crops', 'poor men's crop', 'crops for the future' with known economic value, including many good sources of food and nutrition. These have lost attention over the years because either they were less researched, or less recognized for their nutritional value, or had poor consumer preference/awareness or tagged as 'poor people's crops', overlooked by research, extension services and policy makers. Governments rarely allocated resources for their promotion and development, which resulted in farmers planting them less often and reduced access to high quality seeds.

Scientists and policy makers are now increasingly recognizing that securing future food and nutrition security requires a paradigm shift from the conventional Green Revolution-like technologies that were successful in the late twentieth century. One such approach is to explore non-conventional pathways such as wider adoption of UUCs, as possible future crops due to the fact they are adapted to a range of agro-ecologies, are nutrient-dense and offer better prospects in marginal production areas with low-input agriculture. In fact, this approach is an affirmation of sustainable farming systems and human well-being known to indigenous local communities for generations. The domestication of new crops would promote agricultural diversity and could provide a solution to many of the problems associated with intensive agriculture. Being nutritionally very rich, they have proved good potential for food and nutritional security, health and income generation especially for local communities. The use of modern science to improve their productivity, value addition and use by agro-industries are new opportunities that need to be harnessed.

The APR possesses rich genetic diversity of a large number of UUCs that have great economic potential for exploitation. Crop groups and crops with great potential include pseudocereals (amaranths, buckwheat and chenopods), millets (finger millet, proso millet, foxtail millet and kodo millet), grain legumes (rice bean, adzuki bean, faba bean, moth bean and horse gram), tubers (taro, giant taro, greater yam elephant foot yam), vegetables (hyacinth bean, sweet gourd, cho-cho, horse radish tree, kangkong and garden cress) and fruits (bread fruit, longan, durian, rambutan, mangosteen, carambola, seabuckthorn). These crops possess exceptionally high food and nutritional value, including higher amount of essential amino acids and minerals as compared to many cultivated crops. Hence, they are extremely useful in alleviating malnutrition which is so widely prevalent. The manifold benefits of these species are: (i) contributing to poverty alleviation through employment opportunities, income generation and sustainable livelihood as they can widen the food basket, (ii) adding nutrients to diet and sometimes convenient food for low income group people, (iii) adapted to fragile environments and can contribute to the stability of agro-ecosystems, particularly in arid, semi-arid, mountains and tropical forests, (iv) providing wider portfolio of crops for new market demands, and (v) assisting development through value addition and secondary agriculture.

Successful food systems effectively draw on locally available food, food variety and traditional food culture. This involves concerted efforts in research, public policy, promotion and required action in support of multi-sectoral and community-based strategies linking rural producers and urban consumers with traditional and underutilized food systems. Paucity of agronomic and nutritional information, negative public perception towards traditional foods, policies not recognizing sufficiently their important role in food security and health benefits, and lack of markets, are few important aspects which need attention. While the value of these hardy staples under climate change is clear, it is essentially required to give attention to UUC/NUS to promote more balanced diets so critical for good health. Initiatives on R&D and promotion of these species in the past has been done by Bioversity International (*e.g.* kodo millet in India and *Digitaria* in Mali), Crops for the Future (CFF), FAO's Regional Office for Asia and the Pacific (RAP) on underutilized grain legumes and pseudocereals, All India Coordinated Research Project on Underutilized Crops (now All India Coordinated Network on Potential Crops) at the ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR). The development and commercialization of UUC/NUS is also one of the priority activities of the Second Global Plan of Action for Food and Agriculture, under the aegis of FAO Commission on Genetic Resources for Food and Agriculture adopted in November 2011. Recently, the 'Delhi Declaration on Agrobiodiversity Management' adopted during the '1st International Agrobiodiversity Congress (2016)' laid emphasis on use of crop wild relatives in crop improvement.

Thus, keeping in view the immense importance of UUCs and the fact that greater attention is required in their R&D and promotion, the APAARI under its program on APCoAB and the Council of Agriculture (COA), Taiwan, in collaboration with the World Vegetable Centre (WorldVeg), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Crops for Future (CFF), International Centre for Agricultural Research in the Dry Areas (ICARDA), Bioversity International and Department of Agriculture (DOA), Thailand, organized the "Regional Expert Consultation on Underutilized Crops for Food and Nutritional Security in Asia and the Pacific", from November 13-15, 2017, at Rama Gardens Hotel, Bangkok, Thailand.

Objectives

The objectives of the Regional Expert Consultation were:

1. To create much needed awareness on the role and value of underutilized crops (UUC/NUS/orphan crops) that have potential for diversification of food basket to ensure better food and nutritional security in APR.
2. To share experiences and learn lessons to accelerate the use of underutilized plants as crops for the future.
3. To assess R&D status on priority crops and policies that are needed to promote the use of these crops in the APR.

Opening Session

The Regional Expert Consultation on Underutilized Crops for Food and Nutrition Security in Asia and the Pacific commenced with a welcome address by **Ravi Khetarpal**, Executive Secretary, APAARI, Bangkok, Thailand. He extended warm greetings to all the participants, including those from sponsoring organizations and members of APAARI, and presented mementoes to dignitaries on the dais. He briefly highlighted the importance of the Expert Consultation and need for developing enhanced partnership and a roadmap for focussing on underutilized crops in the APR.

The context of the Expert Consultation was set by **Raj Paroda**, Senior Advisor, APAARI and Chairman, TAAS, India. He said that although poverty reduction had been achieved globally, but household nutritional security was still a major concern. He said in spite of the existence of >20,000 plant species of food value, diversification of food basket was yet to be accomplished. He pointed out that the SDGs adopted by the UN in September 2015, have the targets of 'No Poverty' and 'Zero Hunger' building on the Resolution, commonly known as "The Future We Want". APR faces major challenge of hunger and malnutrition to an extent of 63% of the world's chronically hungry people. Globally, around 30% of the world's population suffers from one or more micronutrient deficiencies such as zinc, iron and vitamin A. Further, around 10 million children die each year before they attain their 5th birthday and 2 out of 5 below the age of 5 years are stunted and malnourished. In this scenario, Raj Paroda opined that agriculture is a critical sector to help achieve the SDGs. While the existing system of agriculture, which focuses on a few major food crops, may have succeeded in ensuring food security in the past, its ability to continue doing so in the twenty-first century calls for greater diversification of cropping systems. He opined that the potential of UUCs crops is tremendous in this regard, especially for the APR. According to him, these plants required more R&D efforts, so that they can be used for the benefit of both consumers as well as farmers. He informed about some initiatives taken earlier on UUCs such as the Global Facilitation Unit for Underutilized Species established in 2002 at the Bioversity International (formerly, International Plant Genetic Resources Institute, Rome, Italy) under the umbrella of the Global Forum on Agricultural Research (GFAR) headquartered in Rome, Italy. This program now worked as Crops for Future (CFF) in Kuala Lumpur, Malaysia. Similarly, a Regional Symposium on Promotion of Underutilized Indigenous Food Resources for Food Security and Nutrition in Asia and the Pacific, on May 31, 2012, was organized in Thailand by FAO RAP, Bangkok, Khon Kaen University in Thailand, National Research Council of Thailand, Japan International Research Center for Agricultural Sciences (JIRCAS) and CFF to raise awareness on the role and value of underutilized indigenous food resources in dietary diversity and household food security; to share experiences and lessons learned for the promotion of partnerships and networking among stakeholders; and to identify policy options and strategic actions for the promotion of underutilized indigenous food resources in the APR. He also mentioned that many neglected UUC are now getting global attention.

In the recent past, when UN declared 2015 as the 'International Year of Quinoa' (*Chenopodium quinoa*), the whole world became aware of its nutritional value resulting in its enhanced use. Some other UUCs that have recently gained prominence are finger millet (*Eleusine coracana*), grain amaranth (*Amaranthus caudatus*, *A. cruentus*, *A. hypochondriacus*), buckwheat (*Fagopyrum esculentum*), rice bean (*Vigna umbellata*), and can be termed as 'Nutricrops'. Paroda hoped that the Expert Consultation would provide a suitable platform for all the participants to share experiences with each other and take stock of R&D achievements and gaps for the UUCs. He urged for more intensification of research on these crops in the NARS. He was hopeful that after the three days deliberations, a clear roadmap would be developed for a strong partnership and networking of stakeholders from APR.

Vincent Lin, Deputy Director General, Department of International Affairs, Council of Agriculture (COA), Taiwan, in his remarks expressed gratitude to APAARI and all the sponsors for organization of the Expert Consultation. He said that challenges for food and nutrition security were getting severe, especially under the impact of climate change. It is, therefore, essential for international organizations and institutes to work together in the areas of smart agriculture, biotechnology, market chains and UUCs. He was happy

that so many experts had gathered to share their experiences and convinced that the meeting would come out with concrete suggestions for enhancing food and nutritional security in APR.

Lin informed about the long collaboration between COA and APAARI. He congratulated the organizers for the initiative taken for holding the Expert Consultation and assured that a series of consultations would be held by COA, Taiwan. He concluded his remarks with special thanks to Raj Paroda for his guidance and experience and hoped for a fruitful outcome of the meeting.

Suwit Chaikiattiyos, Director General, Department of Agriculture (DOA), Thailand, in his remarks congratulated APAARI to host the meeting and for selecting Bangkok as the venue. He said that the second of the 17 SDGs is “End hunger, achieve food security and improved nutrition, and promote sustainable agriculture”, an agenda recognized by all agricultural research institutes since long. He informed that UUCs are source of income to many local and indigenous communities. He hoped that the outcome of the meeting would act as guiding principles on focusing key issues of mainstreaming of UUCs required to overcome many hurdles such as production and productivity, post-harvest processing, consumer acceptability, induction into market chains, and suggest pathways for the benefit of smallholder farmers in the APR.

Fenton Beed, Deputy Director General, WorldVeg, Thailand, in his remarks said that agriculture was facing unprecedented times, with rapid increase in population, decrease in productivity, and changes in farming systems that need to be responsive to consumer preferences. The UUCs have greater resilience to biotic and abiotic stresses, but require more effort and support for production, and are normally viewed as form of subsistence agriculture. The WorldVeg Centre initiated many breeding programs in UUCs due to the need for diversification to new crops, that inherently have a lot of diversity (landraces/farmers varieties). He also opined that there is need to embrace the private sector in this endeavour, besides making consumers aware and develop value chains. Beed emphasized on the need of applying solid science to make UUCs commercially viable. He also underlined the fact that different crops required different approaches for mainstreaming.

Yusuf Zafar, Chairman, APAARI, Thailand & Chairman, Pakistan Agricultural Research Council (PARC), Pakistan, in his remarks voiced concern for the declining biodiversity, climate change and increasing population. In such a scenario, it is imperative that self-sufficiency in food is assured. For instance, Singapore has been rated as the second-most food secure country in the world, behind only the United States, based on factors of affordability, availability, quality and safety. This has been possible due to policies that seek to diversify the source of food imports. A whole paradigm shift has occurred from the MDGs to the SDGs, wherein it is now envisaged that nobody should sleep hungry. He urged that R&D on UUP/NUS should focus shifting them from niche areas and linking them to larger markets, as has been in the case of quinoa and moringa.

Hiroyuki Konuma, Meiji University, Thailand, in his inaugural address¹ expressed his delight to speak on UUCs, a subject with which he had been associated life-long. He said that UUC become important when natural resources are shrinking (especially water) and climates are changing rapidly. He mentioned that the report on "Status of World Food Security and Nutrition" released by the UN in September 2017, indicated increase of chronic under-nourished population. Some 815 million chronically food-insecure and malnourished people have been recorded by 2016, of which a vast majority (60%) live in countries affected by conflict. The food security situation has worsened in particular in parts of sub-Saharan Africa, South-Eastern Asia and Western Asia, and deteriorations have been observed most notably in situations of conflict and conflict combined with droughts or floods. Another major challenge was climate change. He said that we have committed to eradicate hunger to zero, as reflected in SDG 2, which would be challenging – achieving it will require renewed efforts through new ways of working with joint efforts. He urged for creation of a strong teamwork to achieve food security, as there is need to look out for generations to come. He informed that FAO had predicted that to meet the per capita food requirement by 2050, a 60% increase in food production would be required, based on statistics of 2005-07. As there are

¹ For full text see Appendix II

only 33 years to go, we may face difficulty in reducing chronic hunger globally. He also mentioned that although we have eight million chronically hungry people, but 2.8 billion suffer from obesity and 2 billion from nutrient deficiency!

Konuma also highlighted the importance of biodiversity. He said that we are now dependant on four key resources - wheat, rice, maize and potato for 60% of calories supply. Most research and marketing centres around these four food crops. Others are either neglected, lack attention or resources for research. This lack of diversity reduces resilience to climate change. Giving the example of IRRI which had released saline/drought tolerant rice varieties, Konuma said that the success was achieved due to availability of landraces, thus, highlighting the importance of genetic diversity. He reiterated the growing concern for biodiversity conservation, and the negative consequences resulting from loss of agrobiodiversity. He said that FAO has laid stress on the importance of UUCs, especially those produced in wetland, swamps, *etc.* As many UUCs are adapted to low input agriculture, their use can have positive impact on food security. Thus, Konuma urged that increasing research on UUCs should not only be for food security, but also for benefit of farmers livelihood and well-being. He gave example of the work done by him on rambutan (*Nephelium lappaceum*) and sago palm (*Metroxylon sagu*), UUCs growing in wetlands/swamps of South-East Asia. He said that the sago gives very high yield of starch (10-15 tonnes per ha). He said that traditional methods with some modification can popularize its use (sago palm starch blending with wheat for noodles give original taste). However, the population of palms have dramatically decreased due to reduction of wetlands and increased cultivation of oil palm and rubber trees. Konuma concluded his speech by calling for greater research, pre-breeding, policy and funding support for the UUCs.

The session was concluded by a formal vote of thanks by **Rishi Tyagi**, Coordinator, APCoAB, who thanked Drs Konuma, Raj S. Paroda, Yusuf Zafar and Ravi Khetarpal and acknowledged the contributions made by all the organizers, sponsors, participants, logistic providers and all the members of organizing committee of APAARI Secretariat.

Technical Session I: Thematic Technical Presentations

Co-Chairs	: N.K. Krishna Kumar, Bioversity International, India K.S. Varaprasad, Ex-ICAR, India
Rapporteur	: Umesh Srivastava, Ex-ICAR, India

The first session comprised nine presentations from six countries with the objective to cover various categories, diversity, use and management strategies of UUCs.

Benard Ngwene (Leibniz Institute, Germany) made a presentation on '*Underutilized Crops for Food and Nutritional Security: Global Scenario*' and provided an overview on the status food production and persistence of hunger, largely as product of various and severe inequalities. The pattern dietary insufficiencies highlight the need for new food strategies to benefit the vulnerable. Ngwene provided examples of indigenous (mostly neglected and underutilized) crops of many rural communities from Africa, Asia, South and Central America. He provided strategies to mainstream UUCs, by detailing the leverage points of each level within the food supply chain. He also called for recognition and commitment of multi-stakeholders comprising farmers, researchers, traders, consumers and policy makers. Successful models for the new superfoods such as quinoa and moringa products can serve as examples. He concluded by saying that to exploit the full potential of UUCs, a coordinated holistic efforts at local, regional, and international level needs to be made, which requires a fully committed multi-stakeholder approach.

Max Herriman (CFF, Malaysia) made a presentation on '*Crops for the Future: Agricultural Diversification to 2017 and Beyond*' and provided an insight into the programs and agenda of CFF to support the global initiatives on UUCs. He informed that CFF is the Secretariat to the Global Action Plan for Agricultural Diversification (GAPAD). The UN Sustainable Development Agenda 2030, SDG2 had shortlisted GAPAD for the SDG2 Action Items. With the launch of 'The Forgotten Foods Network' in November 2017, CFF is implementing its 'Connect Initiative' as proof-of-concept value chain that spans genetic resources to potential markets for particular UUCs at any location. He also informed about the CFF's work on developing a Global Knowledge Base for UUCs, which comprise development of databases and apps, for diversification of agriculture. Herriman further informed about the 'SNAP' program, acronym for Sustainable Living, Nutritious Diets and Partnerships. Under this a pilot project in Kuala Lumpur involved teaching sustainable culture school communities for raising healthier students in peri-urban settings. Herriman proposed several areas of collaboration with APAARI in relation to CFF programs and projects.

Anjula Pandey (NBPGR, India), spoke on '*Underutilized Plant Species in Asia-Pacific Region*' and presented an overview on the richness in major centres of origin and diversity of crop plants with special reference to UUCs in the APR. The food basket of the APR consists of 778 UUP with underutilized fruits and vegetables represented as the highest number followed by tubers. Amongst the mega-biodiversity regions, the APR covers four regions viz., Chinese-Japanese, Indo-China-Indonesia, Australia-Pacific and Indian region. The plant diversity in Indonesia (total-37,000 species; endemic-14,800-18,500), PNG, Madagascar and Australia have highest percentage of endemic species but regional data on UUP is not available. As large number of NUS are available for use, prioritization among species needs to be done to focus on specific lines of development of crop. The criterion could be based on ethnic and cultural diversity (preference for food-ways/methods of use), relative importance of species in an area; ecology suitable for plant growth; local/regional/national needs, endemic vs introduced policy issues; religious use. Crops with vanishing/lost crops status, come back crops such as buckwheat (*Fagopyrum esculentum*), ragi/finger millets are to be rated higher than others; likewise crops that are easy to prepare, handling while processing/cooking are preferred by women folks over others. She presented a few success stories in crops like oil palm, soybean, kiwi, and the role of consumer awareness and networking for promotion of these crops. Transition from "Underutilized Plant Species" to "Underutilized Crops" has taken place through domestication process in which custodians/farmers, tribals/communities have contributed tremendously in shaping this diversity over a long period. To promote enhanced utilization of the UUCs, regional networks (partners to share/

exchange of information knowledge); networking/linkages using web-based tools and online methods for interactions, strengthening of public and private partnership, collaboration among regional partners/agencies for research and development; stronger genetic resource management to promote exchange/collection/conservation; human resource development through exchange of scientists, technicians, researchers; including knowledge enhancement through academics and school curricula should be taken up on priority. The most important factor contributing towards better adoptability by consumer is through popularization and value addition going along the modern trends (lifestyle); here seeking help from the food science departments is desirable.

Ashutosh Sarker (ICARDA, India), presented work on '*Grasspea: A Neglected but Important Pulse Crop for Nutritional Security of Low-Income People*'. He said that grass pea (*Lathyrus sativus*), is a multipurpose hardy crop, that needs less care, is easy to cultivate with low-cost as it has less biotic and abiotic stresses, adapted to no tillage, can grow in problematic soil and has yield potential up to 4.1 tons seeds, and 18 tons fodder. But it has an ambivalent reputation as its plant parts contain ODAP, a neurotoxin that causes neurolathyrism when consumed for prolonged period. Origin and primary diversity of the genus *Lathyrus* is in the Fertile Crescent of Near East. ICARDA genebank conserves about 4,000 accessions of cultivated and wild species of *Lathyrus*. Genetic enhancement program was initiated at ICARDA to develop free/low-ODAP, short duration grasspea varieties with high biomass suitable for cultivation as relay crop and sole/mixed crop and for fodder. This has resulted in many region-specific, low-toxin and high-yielding improved varieties which are being introduced in various cropping systems through extension and awareness programs.

Ray-yu Yang (WorldVeg, Taiwan) presented her talk on '*Nutritionally Rich Underutilized Vegetables*'. She flagged the issue regarding fully capturing the nutritional treasures in our diets. She informed that although various phytonutrients were present in African and Asian traditional vegetables, the commonly consumed vegetables excluded many of these. She elaborated on the classification of the dietary phytochemicals, highlighting their key species source. She cited examples of many vegetables which provide high content of specific nutrients like iron, vitamin C, E, folates, etc. Based on empirical data of comparative studies on region-specific consumption of traditional vegetables, she advocated for re-introduction of phytonutrient rich traditional vegetables for healthier diets.

Umesh Srivastava (Ex-ICAR, India), in his presentation on '*Diversity in Edible Wild Plants: A Case Study with Bastar Tribal Pockets*', exhaustively elaborated on the wild edible species found in the APR, including their economic importance. He then described use of wild edible species by tribals of 'Bastar' region (in the state of Chhattisgarh, India) in central India. He provided detailed floristic distribution of edible species in various regions of Bastar, including endemic species. He recommended that there was urgent need to document, sustainably use, breed and share not only the useful wild and edible germplasm from tribal regions like Bastar, but also systematically document the indigenous technical knowledge.

Binu Cherian (HarvestPlus, India) made a presentation on '*Biofortification in Underutilized Food Staple for Nutrition in Asia and Africa*'. He said that deficiencies in micronutrients such as iron, zinc and vitamins that cause profound damage to humans could be overcome by a four-pronged approach comprising supplementation, dietary diversity, fortification and biofortification. He elaborated the advantages of biofortification, a process of developing nutrient-dense (e.g. vitamin A, iron and zinc) staple food crops through conventional breeding that are higher in yield and with farmer's preferred traits, and importantly bioavailable. He outlined the process of developing biofortified crops and informed that more than 130 crop varieties had been released in 25 countries so far. Some important ones included Fe and Zn fortified pearl millet, Zn fortified rice and wheat, pro-vitamin A fortified sweet potato, cassava, maize, etc. He also demonstrated the important role of partnership, networking, awareness generation and marketing in the success of spreading the biofortified varieties to nearly 2.9 million people. He concluded by informing that the HarvestPlus program had the target of making biofortified crops accessible to 1 billion people by 2030.

Annamalai Sivapragasam (CABI, Malaysia), while delivering a presentation on '*Knowledge Management Resources in CABI for Underutilized Crops*' elaborated on the key Knowledge Management (KM) resources/tools that could be useful to support the UUC initiatives. These included books, e-books, multimedia tools,

Global Open Data for Agriculture and Nutrition Action (GODAN), mobile advisory services such as m-Kisan and m-Nutrition, KM services that entail managing research information, mobile agri-services, systematic reviews, plant-wise; agricultural and biodiversity research compendiums such as the Invasive Species Compendium. He said that though no specific KM dedicated program had been developed by CABI as yet for UUCs, the existing KM platform helps bring global information, including those of UUCs, to support project work.

Anshul Agrawal (RIMES, Thailand), made a presentation on '*Forecast Application for Risk Management in Agriculture: Case Study from Tamil Nadu, India*'. Using the example of agricultural situation in Tamil Nadu, Southern India, he informed that major constraints in agriculture growth were growing water scarcity, land degradation, declining farm sizes, rising costs, climate-related disasters, droughts and floods, and high incidences of pests and diseases. This necessitated effective utilization of available information and forecasts, while also building capacity of farmers to bring these in practice. This needs a shift from water-intensive crops to coarse cereals with value-additions, to meet emerging demands and, to reduce climate sensitivity. Lack of climate knowledge, clear understanding of forecasts and lack of confidence to make decisions based on forecast were the foremost constraint to be addressed. He described the Forecast Application in Risk Management (FARM) School process, which provides customized modules for the agriculture department officials, extension workers and farmers with help of local partners for increased capacity of farmers to understand the weather forecast and make use of it in their regular farming operations, so that they have the capacity to maximize the advantage of potential favorable climate during the season as well as manage potential risks. He also elaborated on Specialized Expert System for Agro-Meteorological Early Warning for Climate Resilient Agriculture (SESAME), a dynamic crop information forecast tool panel for expert user and farmers for weather bulletins, real time verification of forecast products which helps in generating contingency plan and crop-specific advisory.

As a result of in-depth discussions, the following important points/observations emerged:

- Commercialization of UUCs is often a difficult aspect. This requires seed systems to be in place on priority along with production, processing and value chain with a view to tag the value for consumer.
- While taking poor men's food to the supermarket, heritage value with nostalgic link to the urban consumer may enhance the marketability.
- Nutritional and quality value analysis is a pre-requisite to tag the value for consumer and to convince the policy makers.
- While promoting UUCs for their nutritional value, it is equally important to give attention to food recipes that use them as a major ingredient.
- It is very important to retain the affordability of value added products to low income groups particularly in remote areas for consumption, addressing the nutritional security prior to marketing for urban populations.
- Effective awareness programs in rural areas are derived extremely important. It is desirable that the farming families consume these value-added products derived from UUCs and in addition if it becomes an income source.
- It is necessary to study the cases of moringa and quinoa to learn lessons from both success and failure in promoting them as super foods and on how wide acceptability or awareness was brought out.
- Precautionary approach is needed to avoid promotion of crops for value of one component while other component (such as oxalates leading to kidney stones) may lead to health issues, as many of these crops lack complete chemical profiling.
- Students and young researchers need to focus research on UUC/NUS and institutional mechanisms (e.g. scholarships) need to be made available to encourage such research.
- The ecosystem services (e.g. soil formation, nutrient cycling, climate regulation, disease regulation, water regulation, pollination) of the UUCs should also be studied. Floral biology, pollination mechanisms and natural enemy complex of wild species also need renewed attention.
- Policy based interventions like food subsidy, cultivation subsidy and promotion of government food schemes (e.g. mid-day meals, promotion of multi-grain flour, etc.) would significantly promote UUCs, and address the welfare of the poorest of the poor.

Technical Session II: Strategies on Underutilized Crops for Food and Nutritional Security

Co-Chairs	: Darab Hassani, Iran Ray-yu Yang, WorldVeg, Taiwan
Rapporteur	: K.S. Varaprasad, Ex-ICAR, India

The second session comprised six presentations from two countries with the objective to cover specific crops/crop groups of UUCs.

Kuldeep Singh (NBPGR, India), spoke on '*Strategies on Underutilized Crops for Food and Nutritional Security: Pseudocereals*', which gave an overview of the work undertaken under the ICAR's All India Coordinated Research Network (AICRN) on Potential Crops (formerly, All India Co-Ordinated Research Project on Underutilized Crops). The main objective is to generate improved technologies in selected crops of the minor economic importance for food, fodder and industrial use comprising pseudocereals, food legumes, vegetables and oilseed crops. The NBPGR, New Delhi, is coordinating and conducting research on 17 crops of food, fodder and industrial value through 14 main, 9 cooperating and 15 voluntary centers located in diverse agro-climatic zones of India. Amongst the pseudocereals, evaluation of germplasm had been carried out in grain amaranth (*Amaranthus* spp., 5,822 accessions), buckwheat (*Fagopyrum* spp., 1,000 accessions), grain chenopods (*Chenopodium* spp., 197 accessions.). He presented the data pertaining to the diversity analysis, nutrient content, varieties developed and value-added products in all the crops. Finally, specific traits requiring further research in each of these crops were highlighted.

Hari D. Upadhyaya (ICRISAT, India), made a presentation on '*Underutilized Climate-smart Nutrient Rich Small Millets for Food and Nutritional Security*'. He gave an overview on the mission and vision of ICRISAT, which focuses on specialization in crops suitable for the drylands, especially sorghum, pearl millet, finger millet, groundnut, chickpea and pigeonpea. The ICRISAT genebank conserves 125,050 accession, of six mandate crops and five small millets, originating from 144 countries, and some 1.47 million seed samples had been distributed to 148 countries for research and breeding. The small millets comprising finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), proso millet (*Panicum milliaceum*), kodo millet (*Paspalum scrobiculatum*) and barnyard millet (*Echinochloa* spp.) are considered as climate-smart and nutrient rich crops. However, they remained neglected in terms of support for production, promotion, research and development. ICRISAT has amassed more than 71,279 accessions of small millets from 56 countries. For effective use, mini-cores (10% of core, 1% of entire collection) have been identified from which trait-specific germplasm sources for important traits such as blast resistance, drought and salinity tolerance, early maturity and high nutrition and yield have been identified. He concluded by stating that greater efforts were still required for germplasm collecting, conservation, evaluation and utilization for developing high yielding cultivars, developing better processing and utilization technologies, this required adequate policy innervations too.

Jai Chand Rana (Bioversity International, India), presented a paper on '*Underutilized Grain Legumes: Rice bean, Moth bean, Adzuki bean, Faba bean and Horse gram*' and highlighted the role of Bioversity International in delivering scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity to attain sustainable global food and nutrition security. He also presented the data on the research undertaken in the five crops ricebean (*Vigna umbellata*), moth bean (*Vigna aconitifolia*), adzuki bean (*Vigna angularis*), faba bean (*Vicia faba*) and horse gram (*Macrotyloma uniflorum*), besides providing the strength and weakness of each crop. He advocated that promotion of UUCs required a participatory approach, application of scientific tools and techniques, education and training to improve rural health and economies.

Arshni Sanjita Shandil (CePACT, Pacific Community, Fiji) made a presentation on '*Importance of Root and Tuber Crops for Food and Nutritional Security in Oceania*'. She informed about the role of Secretariat of

the Pacific Community (SPC) in promoting and supporting the conservation and utilization of root and tuber diversity, as one of the solutions to manage many challenges in Oceania. The CePaCT houses a unique collection of over 850 accessions of taro (*Colocasia esculenta*), as well as other crops (cassava, sweet potato, yams, potatoes) and trees of importance to the region, and is building a "climate-ready" collection, consisting of local crops and varieties selected because such diversity will provide the farmers in this region with the traits, such as drought and salt tolerance. They are also facilitating access to improved germplasm through crop improvement activities and germplasm exchange. Also important to all Pacific islands is the unique diversity of breadfruit comprising varieties that can be produced all year round. Other aroids, such as the swamp taro, is an important staple crop of the small countries such as Tuvalu and Kiribati. The outbreak of the taro leaf blight disease (TLB), in Samoa in 1993 was a wake-up call to the Pacific region in realizing the need for greater diversity. Through effective conservation and utilization, dynamic sustainable agricultural systems are being sought to be achieved.

N.K. Krishna Kumar (Bioversity International, India) made a presentation on '*Underutilized Tropical and Subtropical Fruits for Nutrition and Health Security and Climate Resilience - A Bioversity International Initiative*'. He described the enormous wealth of minor fruit and nut species available globally, belonging to 4,200 temperate and tropical species. He informed about the various initiatives taken by Bioversity International on fruit species conservation. Major activities in these projects encompassed exploration and collection of minor fruit species of tropical and subtropical region, genetic variability analysis and characterization, documentation of traditional knowledge, analysis of food and nutritional value, identification of potential minor fruits for mainstreaming and networking of custodian farmers. He also informed about the Genetic Diversity Park of fruit crops being developed at the Bioversity International office, Bengaluru, Karnataka, India. He flagged some of issues that required attention in future. These were resurvey and documenting the genetic diversity of underutilized fruit species, characterization of all the species and available varieties along with their wild relatives and *ex situ* conservation, documentation of available worldwide information on ethnobotanical aspects and traditional knowledge including local food recipes, in depth studies on chemical analysis with respect to food and nutritional and other health benefits, developing multiplication protocol and good agricultural practices to get better production, improved quality for higher income, promoting custodian farmers approach for effective conservation and sustainable utilization, developing value chain and market support and popularizing family nutrition garden involving women self-help groups.

Virendra Singh, (CSKHPKV, Palampur, India) spoke on the '*Potential of Seabuckthorn (Hippophae L.) - A Multipurpose Underutilized Crop of Dry Temperate Himalayas*'. He described the enormous ecological and economical potential of the plant and compared the nutrient profile with some other common fruits, to show its superiority in elements like Vitamin C, E, riboflavin and niacin. He then described the work undertaken on genetic diversity analysis, variety development, product development and value addition in the crop. He further enumerated the health benefits that can be harnessed from the use of this species. Finally, he suggested the areas of research that require attention in this crop. These include evaluation trials on Russian seabuckthorn in Himalayan states, development of hybrids between local and Russian forms of seabuckthorn, and improvement in local thorny and low yielding forms, clinical research on seabuckthorn oil for use in cardiovascular diseases and diabetes.

The presentations followed in-depth discussions which resulted in the following major suggestions/ observations:

- In species, which are predominantly cross-pollinated, mutation breeding could possibly be used for varietal improvement.
- While mainstreaming UUCs and prioritizing list of species, it is important to keep in view the information from the demand side.
- There is urgent need for mapping UUCs in the APR in terms of both genetic resources and expertise.
- Emphasis was laid on specialized scholarship for promoting research on UUCs.
- It was suggested that collaboration between the various countries and organizations would be greatly beneficial.

Technical Session III: Country Status Reports on Underutilized Crops

This session was divided into three groups to include country reports from countries of South Asia, South East Asia and the Pacific. The group-wise details are given in following section.

Group I - South Asia

Co-Chairs	:	<i>Mohamad Roff Bin Mohd. Noor, MARDI, Malaysia</i> <i>Ashutosh Sarker, ICARDA, India</i>
Rapporteur	:	<i>Anjula Pandey, NBPGR, India</i>

In general, country reports provided the status of UUCs crops in their respective countries, zones or regions, the number of species, economic importance and geographical spread. The areas of strength and weakness were also presented and the expectation of each country from such consultations was also discussed. Salient features in each country report is presented below. Detailed country status reports were documented in separate publication.

Bangladesh report was presented by **Rina Rani Saha**, BARC, Bangladesh. She informed that out of the 200 crops grown in Bangladesh, about 100 were minor crops, including fruits and vegetables. Further, there are many indigenous naturally occurring UUP associated with a vast heritage of indigenous knowledge. She enumerated on the need for documentation of UUP, especially the multipurpose species. She laid emphasis on value addition, documentation and awareness generation with respect to these crops. She also flagged the issues of strengthening data systems, information dissemination, developing efficient market chain, thrust on skilled man power and greater R&D thrust. She said that conservation facilities (*in situ*, on-farm, *ex situ*, field genebank, *in vitro*, cryopreservation) for these plants need to be strengthened. She stressed that regional and international cooperation for technical and financial support were required for maintenance of biodiversity as well as R&D of UUCs.

Bhutan report was presented by **Kailash Pradhan**, DOA, Bhutan. He provided the uniqueness of the country in terms of ecology and agriculture and stated that a total of 38 NUS were recorded under different categories. Collection of germplasm comprised 284 landraces, mainly of cereals and pulses. He emphasized on greater documentation of these species. No significant value addition had been undertaken for NUS, although buckwheat noodles and others are being marketed by private entrepreneurs. The challenges lie in areas of marketing, capacity building and human resource development. Government, donors, private sector and research institutions need to work together to promote and conserve UUCs.

India report was presented by **Kuldeep Singh** (NBPGR, India), on behalf of the Director General, ICAR, India. At the outset, he presented the status of germplasm maintained in National Genebank at NBPGR, India, comprising a total of 430,982 accessions, of which UUCs consisted of 13,240 accessions (including 42 released varieties) belonging to pseudocereals, grain legumes, millets and industrial crops. He informed that an 'All India Coordinated Research Project (AICRP) on UUCs which was initiated in 1982 and is now functioning as AICRN on Potential Crops under the umbrella of ICAR, New Delhi. The main objective is to generate improved technologies in selected crops of the minor economic importance for food, fodder and industrial use. He provided the salient achievements under the AICRN in which 800 trials had been undertaken. He informed that in finger millet within 10 decades, the area has been reduced but yield has gone up. But identification of suitable cultivars, processing of the produce, still need study. Further promotion of UUCs required enhancing the efficiency of hybridization techniques in small millets, pseudocereals and grain legumes; evolving varieties for specific end-uses and increased health benefits; development of technologies to manage important pests and diseases during production and storage and development of cost-effective processing technology and improvement of shelf life in finger millet. Issues of supply chain (procurement, bulking, aggregation, storage and processing) need to be studied.

Iran report was presented by **Darab Hassani** (AREEO, Iran). He provided the status of different UUCs needs with respect to identification of research thrust on marketing. He laid emphasis on prioritized crops needing research, collaboration and networking approach.

Sri Lanka report was presented by **Hemantha Wijewardena** (SLCARP, Sri Lanka). He enumerated on the ecology and agriculture of Sri Lanka as well as the important UUCs and the institutes working on these crops. UUCs are important for food and nutritional security in Sri Lanka. However, challenges with respect to UUCs was in their low economic value, low adoptability by farmers, poor consumption by young generation, lack of value addition, low soil fertility management practices adopted by farmers and lack of information available on medicinal and nutritional values. Government organizations in Sri Lanka have given great attention to UUCs, by undertaking proper conservation methods, adopting strategies to popularize food prepared with UUCs. Further research is still needed to explore properties of UUCs and development of crop production packages, extension of activities including food programs, school meals, technology parks to make awareness.

Nepal report was presented by **Baidya Nath Mahto** (NARC, Nepal). He gave an overview on the agricultural priorities in Nepal, and also discussed the research network of NARC, which primarily focused on 17 commodity research programs. Important UUCs under NARC comprise barley, finger millet, buckwheat, amaranths, proso millet, foxtail millet and sorghum. For sustainable agricultural system and promotion of UUCs, priority areas include documentation, linkages and collaboration, prioritization in policy, awareness generation, support local food chains and establish local processing industries and linking with eco-tourism, organic trades, hospitals and school feeding programs.

Pakistan report was presented by **Abdul Ghafoor** (PARC, Pakistan). He gave an overview on the genetic resources program in Pakistan and said that R&D of UUCs was at preliminary stage. Hence, there is need to enhance the exploration and conservation (both *in situ* and *ex situ*), evaluation and utilization of UUCs germplasm as also development of production technology and marketing for the benefit of farmers. The case study of cultivating black cumin *Nigella sativa* with honey production can help in economy enhancement of resource poor farmers. He urged that networking and compilation of R&D work by individual scientists should be prioritized so that regional crop-specific multidisciplinary teams be established.

Group 2 - South East Asia

Co-Chairs	: <i>Fenton Beed</i> , WorldVeg, Thailand <i>Reynaldo V. Ebor</i> , PCAARRD, Philippines
Rapporteur	: <i>Kailash Pradhan</i> , DOA, Bhutan

Lao, PDR report was presented by **Bouthing Bouahom** (NAFRI, Lao PDR). He described how Lao, a land-locked country, is largely an agrarian society (49 ethnic groups) where rice (especially glutinous rice) is the main staple food. UUCs play a significant role in the livelihood of rural households. The National Agro-biodiversity Program of Lao has an ecosystem-based approach comprising paddy, upland, forest, commercial and wetland ecosystems. Several NUS/UUC species such as cultivated and wild yams, yam bean, taro and a large number of non-timber forest species, were used. However, NUS still remain at the level of traditional practice in term of cultivation, post-harvest, storage, processing and trade. A few of NUS products are processed, such as mixed fruit and root crops chips. The major challenge is lack of assured market due to low production and lack of quality and quantity. In Lao, NUS related activities required are conducting survey, collecting, characterization and documentation, research and improvement, production, processing, value addition, marketing and consumption promotion and human resources development.

Malaysia report was presented by **Mohamad Roff Mohd. Noor** (MARDI, Malaysia). He informed that natural rainforests in Malaysia harboured several underutilized fruits (*e.g. Artocarpus, Baccaurea, Durio, Garcinia, Nephelium, Bouea, Mangifera, Canarium, Cynometra, Sandoricum* and *Lansium*), medicinal plants (nearly 1200 species) and Crop wild relatives (CWRs). In addition, more than 120 species of traditional vegetables

existed in Malaysia. He enumerated the survey, collection, characterization, evaluation and conservation activities carried out in institutes like MARDI, FRIM, DOA, UNM. Product development such as pickles, jam and drink from underutilized fruits has helped to promote these species to the public. Some challenges flagged by him included development of competitive and sustainable agro-food industry, increase of income of agricultural entrepreneurs, raising awareness of the consumers and farmers about nutrition and cultivation of UUCs, lack of adequate government support for marketing of UUCs and promotion in international market, insufficient planting material of herbs and medicinal plants. Strategies that have been applied to harness the potential of UUCs in Malaysia include selection, breeding and upscaling to improve quality and demand, fingerprinting and genetic diversity studies, awareness, promotion and conservation of UUCs, diversity products towards health supplement, production through advanced propagation (e.g. shorten plant juvenility) and developing networking through agencies like GEF, Genesys, Bioversity International, Crop Trust, Millennium Seed Bank, Royal Botanic Gardens, Kew, London.

Thailand report was presented by **Nuengruethai Srithornrath** (DOA, Thailand). She gave an overview of the state of agriculture in Thailand and said that urgent need was felt in the country to adopt sustainable development. He described about the R&D activities in eight crops (soybean, mungbean, peanut, bambara nut, corn, sunflower, sesame and sorghum). The germplasm conservation work (32,766 accessions of 153 crops) at Biotechnology Research and Development Office, DOA was also presented.

Vietnam report was presented by **Pham Hung Cuong** (Plant Resources Center, VAAS, MARD, Vietnam) He informed that Vietnam is a country with rich plant diversity, with 13,000 plant species, belonging to 3,500 genera and 500 families, of which 60% have originated in Vietnam. However, climate change is negatively impacting agricultural production, due to sea level rise, drought, flood, storm, saline intrusion, etc. More than 26,000 accessions of over 200 species including food crops, fruit trees, medicinal species are under *ex situ*, *in vitro* and DNA conservation. Although, Vietnam has considerable diversity of UUCs with great potential to contribute to improving the local income, food security, nutrition, there are no dedicated policies or legal instruments by the government towards these species. NUS genetic resources are being eroded, so it is important to develop mechanisms, policies and national strategies, and resources investment to promote their sustainable use. It was suggested that policy support be extended for *in situ*/*ex situ* conservation, expand national database and documentation, improve communication networks and public media, develop market chains, and government subsidies for training, fertilizer and techniques be provided for developing UUCs.

Philippines report was presented by **Reynaldo V. Ebor**a (Department of Science and Technology, PCAARRD, Philippines). He said that out of the 300 fruit and nut species recorded in the country, some 170 indigenous species remain underutilized. Most indigenous vegetables (component of traditional farming systems and home gardens) supplement food and nutritional need of the people but are underutilized. He gave examples of UUCs fruits and nuts (*Canarium ovatum*, *Syzygium cumini*, *Antidesma bunius*), vegetables (*Sesbania grandiflora*, *Broussonetia luzonica*, *Athyrium esculentum*) and root crops (*Colocasia esculenta*) which have great potential. He suggested that R&D efforts on such crops for food and nutraceuticals, can be key to attainment of food and nutritional security in the Philippines.

Taiwan report was presented by **Keng-Chang Chuang**, (Department of Breeding, Floriculture Research Center, TARI, Taiwan). He informed that the National Plant Genetic Resources Center (NPGRC) established in 1993 serves as the genebank under Taiwan Agricultural Research Institute (TARI), Council of Agriculture (COA), mandated for germplasm collection, conservation, and utilization. A total of 91,782 germplasm accessions have been collected and conserved in seed and field genebanks, and 1,734 accessions of sweet potato and potato were held in *in vitro* genebank. Of these, more than 70,000 accessions of germplasm related data including passport, characterization, and image data were stored in an open database system. TARI is committed to breeding new varieties of cereals, fruits, vegetables and flowers which can meet consumer needs. An Advisory Committee of plant germplasm and biodiversity has been organized to evaluate academic research proposals and the other issues pertaining PGR for supporting research and utilization in NPGRC. TARI coordinates and collaborates with all research institutions and university on field collection conservation, documentation and international cooperation.

Group 3 - Pacific Countries

Co-Chairs	:	<i>Bounthong Bouahom</i> , NAFRI, Lao PDR <i>Kuldeep Singh</i> , NBPGR, India
Rapporteur	:	<i>Arshni Shandil</i> , SPC, Fiji

Fiji report was presented by **Savenaca Cuquma** (Koronivia Agricultural Research, Research Division, Ministry of Agriculture, Fiji). He said that agriculture contributes to 7% Fiji's GDP. Sugar industry is major one, accounting for 18% of Fiji's domestic exports, while non-sugar exports (pawpaw, vegetables and root crops) account for approximately 3.8%. The government's "Fiji 2020 Agriculture Sector Policy Agenda" aims to drive transformation of the sector to commercial scale agriculture. The MOA is responsible for all *ex situ* conservation of PGRs at eight research stations through field collections, cool storage and tissue culture. *In situ* conservation is carried out normally for wild relatives of crops and medicinal plants and for on-farm conservation awareness and training are carried out with farmers to conserve their landraces. Several UUCs occur such as Giant Swamp Taro, Bele or *Hibiscus manihot/Abelmoschus manihot*, Tahitian Chestnut, *Xanthosoma* spp., Karat banana, *Pometia pinnata*, breadfruit, *Spondium dulcis*, *Saccharum edule*, Soursop, Water Cress. Many unique genotypes of coconut (pink husked green dwarfs, green tall, brown dwarf and compact crown dwarf) also have great potential for commercialization. Success story of promoting wild yam (*Dioscorea pentaphylla*), drought resistant species tasting like potato, and edible fern (*Athyrium esculentum*) as a delicacy in Fiji coloured sweet potatoes with good nutrition was described. There is need for creating investment opportunities for collaborative R&D, conservation and use, marketing linking to agro-tourism and processing, strengthening the nutritional analysis to enhance promotion of UUC. Collaboration with regional and international organizations was subscribed.

Papua New Guinea report was presented by **Birte Komlong** (National Agricultural Research Institute, PNG). She said that PNG is a biodiversity 'hotspot' with many potential UUCs. Locally grown food crops provide 80% of energy and 57% protein. More than 400 plant species are grown or harvested (many only very locally, when other food is not available). She cited examples of species which had not been fully utilized (*Colocasia esculenta*, *Metroxylon sagu*, *M. salomonense*, *Abelmoschus manihot*), overlooked (*Psophocarpus tetragonolobus*, *Artocarpus altilis*, *Pandanus conoideus*), undervalued (*Musa AA*, *Pometia pinnata*, *Canarium indicum*), forgotten (*Dicliptera papuana*, *D. pentaphylla*, *D. bulbiferam Musa*, Fe'i group) or poorly known (*Ficus copiosa*, *Solanum nigris*). She also informed about high uses of taro, which is now replaced by Chinese taro. Also, decline in consumption of traditional leafy vegetables. She flagged several concerns on promotion of UUCs - who are the customers, who will buy the products, who is supposed to eat the crops, where are the markets? She stressed on a need for harmonization of policies and strategies at international, regional and national levels to prioritize investment in the development of UUCs as well as long-term commitment by international donors and national governments to allocate sufficient resources to unlock the potential of these crops.

Samoa report was presented by **Moafanua Tolo Iosefa**, Ministry of Agriculture and Fisheries, Samoa. He informed the eco-geographic location of the island group country which comprises two main islands with several small islets, with a land area less than 3000 km²; of this nearly 48% is suitable for agriculture. The staple and high value crops are coconut, taro, banana, cocoa, breadfruit, yams, papaya, vanilla, alocasia and *xanthosoma*. Important UUCs include sweet potato (*Ipomoea batatas*), pele/aibika (*Abelmoschus manihot*), tamaligi/drumstick (*Moringa oleifera*), bitter melon (*Mormodica charantia*), and okra (*Abelmoschus esculentus*). The UUCs are important to promote healthy diet, as effective bio-remedies, and an alternative opportunity of income generating for farmers in rural communities. A national strategy plan for promotion, mass multiplication, distribution and commercialization of plants high in nutritional value for must be a priority. For these private sectors need to be encouraged to engage in large scale commercialization of cultivation of UUCs. The MoA has to implement and sustain field conservation and multiplication for distribution of planting materials of UUCs. Public awareness through mass media (radio or television) are required.

Special Session: Women Farmers as Driving Force

Co-Chairs	: <i>Ravi Khetarpal</i> , APAARI, Thailand <i>Hemantha Wijewardena</i> , SLCARP, Sri Lanka
Rapporteur	: <i>Anuradha Agrawal</i> , NBPGR, New Delhi, India

The session commenced by a brief introduction of the speaker, **Eri Otsu**, by Ravi Khetarpal. He informed that she was an activist, a mother and a farmer; in fact the only women farmer amongst the participants of the meeting, cultivating organic rice in Kumamoto, southern part of Japan called Kyusu area. She has a masters degree from Technical University of Munich and studied landscape planning. In 2003, she started working in her family owned farm in Kumamoto. She became Chief Director of HERS, a non-profit organization (NPO) of women farmers in Japan, since 2014. In 2017, she was endowed with the 'Model Farmer Prize' during FAO's Annual Asia-Pacific World Food Day event, for her success in raising the voices of rural women and farmers.

Eri Otsu, began her lecture on "Women Farmers as Driving Force" with a video presentation that briefly gave an overview of her work related to the cause of rural farmers, especially women in farming. This was followed by her power point presentation chronicling her life and achievements. She recalled that when she, a well-educated woman from Japan, told her family and friends that she would settle down as a farmer in a rural area, they all asked her "Why?" Her concerns arose from the fact that rapid growth of GDP in Japan was directly responsible for loss of human, natural and economic resources in the rural areas.

Ms Otsu and her husband agreed to take over the running of their one-hectare farm in the far south of Japan, by primarily growing organic rice. Ms Otsu then put her landscape planning knowledge into practice by promoting renewable energy (biomass and solar) and encouraged other Japanese farmers to follow. She established Kyushu Biomass Forum, a non-profit organization to advocate and raise public awareness of renewable energy benefits for rural development. Technology, she believes, is key to future food security – as the average age of farmers in Japan is approaching 70. Following the earthquake in 2016, her voice became even louder. She launched several projects to optimize rural development. One example was her "Little Farmers School" project, which teaches rural children about food and agriculture. The project received awards from the Ministry of Environment. Ms Otsu also runs a "Restaurant Bus" – a tourism project designed to take visitors to farming areas affected by the quake – so they could try local dishes made from fresh produce from farm sites affected by the disaster. As a key player for the designation of a 'Globally Important Agricultural Heritage Systems Site' in Aso, Japan, Ms Otsu states unequivocally that "Even with a great plan for protecting and improving landscapes, we cannot do so without farmers. As their livelihoods are at stake, farmers themselves are becoming an underutilized species! This forum by APAARI is an important forum to keep in view the role of farmers when strategizing for UUCs for food and nutritional security.

Key Messages

- **Empowerment of Women Farmers:** Women would be the key drivers of change in agricultural development and rural livelihood. Their community needs to be brought together and empowered. A sense of pride needs to be instilled, so that they remain in a happy disposition. For instance, women can be encouraged to "wear a view" of their farms, as a fashion statement, as done by Ms Otsu's NPO.
- **Establishment of Renewable Energy Supply System:** Use of solar and biomass (including those from underutilized plants) for generating energy and agricultural products by a "Solar Sharing System" to be encouraged.
- **Educating Children about Agriculture:** Children should be taught about the importance of agriculture, from very young age, through innovative on-farm projects.
- **Archiving Local Wisdom and Techniques related to Agriculture and Food:** Ensure that traditional techniques and wisdom of the aging farmers and women get documented for posterity.
- **Agricultural Tourism:** As an example, "Restaurant Bus" started by Ms Otsu could be considered for creating new opportunities for rural livelihood.
- **Bringing the World Together:** Encourage seminars, workshops, meetings, to exchange ideas for sustainable development.

Technical Session IV: Working Groups Discussion

The session was structured to brainstorm on four thematic areas, and experts were asked to join the groups of their interest. The themes comprised (i) production and crop improvement, (ii) value addition and marketing, (iii) partnership and capacity building and (iv) biotechnology for enhancing utilization. The major recommendations emerging from the group discussion are given hereunder.

Working Group 1: Production, Conservation, Improvement and Crop Management

Chair : H.D. Upadhyaya, ICRISAT, India
Facilitator : K.S. Varaprasad, Ex-ICAR, India

Key highlights

Germplasm management

- There is a need for systematic collecting of diversity of selected UUC/NUS, to ensure that gaps are not left.
- The collected germplasm needs to be stored under medium-term and long-term conservation using crop-specific protocols.
- In case of vegetatively propagated crops like fruits, tuber, bulbs, etc., conservation may be undertaken *in situ* (on-farm, home gardens) or *ex situ* (*in vitro*, cryo or field genebanks), including a participatory approach.
- Germplasm evaluation and characterization should focus on food and nutritional composition as well as agronomic traits.
- Documentation needs to be done with respect to passport data, indigenous/traditional knowledge, characterization and evaluation data, nutritional value.
- APAARI should facilitate dissemination of information on crops.

Crop improvement

- Systematic evaluation of germplasm to identify material for direct release as variety or to identify suitable parental lines.
- Based on pollination system, appropriate crop improvement strategy be selected for improving nutritional value and yield.
- In crops where hybrid vigour can be exploited, hybrid testing program may be initiated to identify best combinations.
- Integrated crop management schedules maximizing productivity, nutritive value including key pest management package of practices to be developed.
- Availability of seed and planting material along with seed systems should be put in place. This may be prioritized in selected species of field crops (finger millet, rice bean, buckwheat, amaranth, safflower, sesame), vegetables (amaranth, kon kong, chenopodium, spine gourd) and fruits (seabuckthorn, berberry, jackfruit, moringa, fox nut, *Buchanania lanzan*, jambolan).

Working Group 2 : Utilization : Value addition. Marketing and Export

Chair : Dhruvad Choudhary, ICIMOD, Nepal
Facilitator : Jai Chand Rana, Bioversity International, India

Key highlights

It was agreed that attention should be drawn to following points :

- Considering the vast number of UUCs existing, prioritization of crops should be done at national level, for their development as diversified products for large markets.
- Development of pro-poor value chains, although there are limitations of the scale in this case.
- Categorization of crops/products and product development, research backup, promotion, advertisement.
- Market intelligence and strategies. Local markets, conventional markets, target markets (out of box).
- Market education to farmers' - motivation/awareness.
- Policy intervention of PDS, mid-day meal, school menu, moving markets, WHO/emergencies.

Working Group 3 : Partnership and Capacity Building

Chair	: Mohamad Roff Bin Mohd. Noor, MARDI, Malaysia
Facilitator	: Anuradha Agrawal, NBPGR, India

Key highlights

It was unanimously agreed that strong partnership between IARCs, NARS, Universities, Regional Networks, NGOs, NPOs, Scientific Societies and Farmers Groups was required to strengthen work on UUCs. The discussion led to some key strategies and the commensurate activity or initiative required to accomplish effective networking and partnerships, as enumerated hereunder.

Partnership

- **Policy Advocacy** - Formation of 'Steering Committees' at national level comprising policy makers (e.g. Ministry or Department of Agriculture), researchers, NGOs/NPOs, private industry players (especially for value addition) and farmers representatives. The Steering Committees should coordinate R&D activities at national level and make policy decisions on behalf of the government, besides monitoring fund allocation. 'Working Groups' and 'Technical Groups' need to be established at national and regional levels. The Chairs of these working groups to be members of the steering committee. Committees to develop a national policy on UUCs.
- **Networking** - Sharing of information among and between farmers, researchers, extension workers, policy makers and private entrepreneurs need to be facilitated. This can be done by development of databases on crops, experts and research activities at national level, and focal institutes should be identified in each country. Establishment of a knowledge management system at regional level, which may be facilitated by APAARI.
- **Marketing** - Farmers Union, Association of Government Boards, Sale Centres.

Capacity building

- **Development of competencies and skills** - UUCs should be included in school curriculum. Researchable topics need to be assigned to graduate, post-graduate and post-doctoral students; organize training programs; develop human resource exchange of experts.
- **Awareness programs, promotion and marketing** - focus needs to be given on the use of mass media (television, internet, celebrity endorsements), technology parks/incubator parks and food festivals in PPP mode.

Working Group 4 : Biotechnology for Enhancing Utilization of Underutilized Crops

Chair	: <i>Rajeev Varshney</i> , ICRISAT, India
Facilitator	: <i>Rishi Tyagi</i> , APAARI, Thailand

The advantages of application of biotechnological tools in crop improvement, germplasm management and production of quality planting material of UUCs was unanimously acknowledged. However, it was also agreed that various regions and countries had specific priority crops and the kind of biotechnological intervention requirement in each crop/croup group. The specific biotechnological requirements of South Asia, South East Asia and Pacific Countries for UUC of millets, tubers, pulses and fruits are listed hereunder.

South Asia

- *Millets* - Genomic resources, translational research, germplasm characterization, trait development, molecular breeding
- *Tuber* - Tissue culture, genomic resources, germplasm characterization, cryopreservation
- *Pulses* - Translational research, trait development, molecular breeding
- *Fruits* -Tissue culture for mass multiplication and grafting

South East Asia

- Tuber - Tissue culture, cryopreservation, advanced biotechnology
- Pulses - Translational research, trait development, molecular breeding
- Fruits - Tissue culture for multiplication and grafting

Pacific Countries

- Tuber - Tissue culture, cryopreservation
- Fruits - Tissue culture for multiplication and grafting

Technical Session V: Panel Discussion on Policy Support for Underutilized Crops to Achieve SDGs

Co-Chairs	:	<i>Max Herriman, CFF, Malaysia</i>
	:	<i>A. Ramakrishna, NARI, PNG</i>
Rapporteur	:	<i>Anuradha Agrawal, NBPGR, India</i>
Panelists	:	<i>Yusuf Zafar, PARC, Pakistan</i>
		<i>Fenton Beed, WorldVeg, Taiwan</i>
		<i>Reynaldo V Ebor, PCAARD, Philippines</i>
		<i>Kuldeep Singh, NBPGR, India</i>
		<i>Mohammed Roff Bin Mohd. Noor, MARDI, Malaysia</i>
		<i>Rajeev Varshney, ICRISAT, India</i>
		<i>K.S. Varaprasad, Ex ICAR, India</i>
		<i>Benard Ngwene, Leibniz Institute, Germany</i>
		<i>Ravi Khetarpal, APAARI, Thailand</i>
		<i>Dhrupad Choudhary, ICIMOD, Nepal</i>

The session was specifically dedicated to brainstorm on the kind of policy support required at national and regional levels to facilitate the requisite support required by various stakeholders in promoting UUCs to achieve better food, nutrition and health security as envisaged under the SDGs. Ten panelists from eight countries provided their perception on this theme.

Yusuf Zafar, PARC, Pakistan, said that APAARI had organized an Expert Consultation on Medicinal and Aromatic Plants during December 2-3, 2013, and the current meeting on UUCs was on a similar pattern. He expressed his hope that the proceedings of the present meeting would be another milestone achievement for APAARI. He said that this meeting was in the right context to achieve the SDG of zero hunger and nutritional security. Based on country reports presented in the meeting, it was clear that all countries, including Fiji, have developed genebanks. He urged that germplasm of UUCs should be exchanged amongst the participating countries, after this meeting. The habit of free exchange needs to be adopted, as exemplified by Spain which has provided more than 100 genotypes of olive to Pakistan for developing plantations. He opined that free exchange of germplasm between countries is a win-win situation. He further emphasized that the International definition of UUC needs to be followed (e.g. soybean an UUC in small island countries). He concluded by saying that the Expert Consultation was a good beginning for promotion of UUCs, and the Proceedings of the meeting should be shared in all platforms addressing SDGs.

Fenton Beed, WorldVeg, Thailand, congratulated APAARI for organizing this meeting. He said that while there were many plants to promote nutritional security, there is need to focus on development of specific crops. He stressed on the role of traditional knowledge for use of UUCs, which were very successful in vulnerable environments for the needy population. He also emphasized on the need to agree on a definition of UUCs, to collect, characterize and catalogue the germplasm and put in place ABS mechanism to share the germplasm. This requires coordination, networking and knowledge sharing among experts, where organizations like APAARI can facilitate. He cited the example of MARDI where impressive work had been done on these lines. He flagged the issue of emergence of new pests/diseases and nutrient deficiencies with adoption of new crops. Beyond the field, it is equally important to develop stable value chain to reach the market for promoting UUCs. This requires an enabling environment. Actions in this context may include promotion of recipes with UUCs, inclusion in school feeding programs, awareness generation through pop stars, etc. Beed also emphasized on the need to exchange germplasm, as climate change resilient crops would be required. He said women tend to manage more variable cropping systems and their role in development of UUCs was important. While the youth are not attracted to agriculture in general, novel types of crops and products in conjunction with new forms of communication may act as an incentive.

Reynaldo V. Eborá, PCAARRD, Philippines, opined that APAARI should play a role not only in information and knowledge sharing for promotion of UUCs, but also in its advocacy. The Nagoya Protocol on ABS needs to be adopted for conservation and exchange of germplasm in these crops and also requires facilitation. Traditional knowledge and practices with UUCs need documentation. Support to UUCs was required for value addition. He said that convincing funding agencies to support work in these crops or species was difficult and requires resetting of priorities. APAARI can help in this regard by developing a network to tap expertise in CG centers, NARS and Universities.

Kuldeep Singh, NBPGR, India, said that defining UUCs is very important. He said that a shift in understanding these plants, which were mostly grown either as subsistence or relay crops, not in competition to the major crops, may be as intercrops. He opined that encouraging students to do research on these species need to be facilitated through dedicated scholarships (e.g. Monsanto scholarships for wheat/rice). He suggested that APAARI adopt a network approach and fund for development of selected (4-5) crops, e.g. the model of Asian Rice Rockefeller funding. Singh also emphasized on development of a strong germplasm exchange program within countries of the APR, which may be facilitated by APAARI.

Mohammed Roff Bin Mohd. Noor, MARDI, Malaysia, reiterated the need for clear definition of UUCs. He suggested that UUCs may be clustered according to regions, e.g. millets in South Asia and fruits and vegetables in South East Asia. He stressed on the need to formulate awareness programs, capacity building and developing partnerships and networks. There is need to improve the scientific knowledge base and inventorization of traditional knowledge on UUCs. A Centre of Excellence, with necessary expertise on UUCs may be established. Research Institutes and Universities should focus on developing competencies and skills. Collaborative research programs should be developed to enhance capacity and skills. He said that there was need to bioprospect UUCs to develop more novel products. He opined that involvement of private sector was important for development of UUCs. Government support to both public and private sectors was required to enhance technology. For this consortia like Steering Committee, Working Groups, Crop Groups should be encouraged. He also subscribed to increasing institutional and public awareness about UUCs.

Rajeev Varshney, ICRISAT, India, suggested that a document (e.g. baseline paper) be developed to define UUCs, in consultation with the countries gathered in this meeting. He said that while UUCs had no competition with the major crops, they do provide nutritional security. He said funding agencies do not give adequate importance to UUCs and a balance was required. Again a publication would help to address the issue. Communication and public awareness was important, as exemplified by India's request to the UN for declaration of 2018 as 'International Year of Millets' to promote it as nutrition-rich smart food across the world. He said that research on UUCs was required to increase productivity and profitability, more germplasm exchange, and development of basic genomic tools. Farmers need to be connected to the market. He opined that youth can be attracted by making UUCs profitable. He concluded by reiterating the need for public awareness, especially through social media.

K.S. Varaprasad, Ex-ICAR, India, suggested that an agreeable definition of UUCs be developed by making two lists - one global and one local. He expressed his concern for lives of people impaired due to health and hunger. Remedy for global deficiencies and diseases can help in priority setting for UUCs. For instance, availability of cheaper protein sources (through UUCs) would get automatically marketed. He also urged that APAARI should facilitate development of a comprehensive database, which should include sources of material, nutritional advantage, list of experts and gaps with respect to UUCs. Breeding and biotechnology strategies should not only focus on increasing yield, but also target nutritional and industrial value compounds in UUCs. Governments and PDS should be promoting utilization of UUCs, along with networking of NGOs. Government policies in terms of subsidy for cultivation of UUCs and advisory on cropping patterns including UUCs would be helpful. He concluded by urging that competitive international funding be made available for R&D in UUCs.

Benard Ngwene, IGZ, Germany, said that there was need for mainstreaming UUCs for nutrition to generate income and awareness generation was important to achieve this. He said that problems in development and promotion need to be clear so that solutions can be developed accordingly.

Ravi Khetarpal, APAARI, Thailand, said that the first policy paper on UUCs was developed by IPGRI in 2002 (Global research on underutilized crops. An assessment of current activities and proposals for enhanced cooperation) and APAARI in collaboration of ADB and GFAR organized Asia-Pacific Consultations to identify priority research and development needs in agriculture and natural resources for reorienting and reshaping agricultural research agendas and capacities for development (AR4D) in the region in 2009. He opined that a functional definition (rather than just academic) is required for UUCs. APAARI could take a lead in mapping of UUCs in every region. With respect to development of pro-poor value chain, he said that every component needs to be dissected to identify key players and enablers. He also stressed on the need for exchange of germplasm, expertise and the role of biotechnology in improvement. Primary production of UUCs required quality seed availability, and for this, it was important to rope the private sector for the same. The other issue to be addressed is convincing farmers to cultivate more in UUCs. For this seed, information, agronomy practices, motivation and assurance of returns was required. Further, capacity building of farmers is required for marketing of produce and products of UUCs. He said that while it was adequately emphasized by all on capacity building of people, he felt capacity retention was required more! Government intervention was very critical, the promotion of UUCs also required support from other sectors. He suggested that national strategy on UUCs is required. He stressed that the role of media is very important.

Dhrupad Chaudhury, ICIMOD, Nepal, opined that clear and key messages were required as an outcome of this meeting to convince policy makers for providing funds and resources for promotion of UCCs. The use of UUCs would address SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), SDG13 (Climate Action) and SDG 15 (Life on Land). There is a need to develop a clear definition of UUCs. He urged that a change is required from 'crops' (reductionist) to 'systems' (holistic) approach, as well as adopting a trans-disciplinary approach to serve society in ending hunger and nutrition deficiency. There is a need to widen partnerships to include other institutes than agriculture. He urged that while government support is important for R&D, but international agencies are more important to seek funds and strategies to seek their attention should be in place. He suggested that nomenclature for UUCs as "health crops", may be more attractive for policy makers. Steps to popularize the UUCs may include introduction in PDS, inclusion in mid-day meals, promoting local cuisines in tourism, *etc.* He said that with respect to R&D, there was already a lot of information; it needs to be documented and gaps be identified for new research. He subscribed to a participatory approach for conservation and use of genetic resources of UUCs, including promoting custodian farmers. Identification and protection of heritage landscapes (*e.g.* Peru potato park in fragile ecosystem of high-altitude Sacred Valley of the Incas, maintained with biocultural traditions by Quechua communities) could be a novel approach. He urged for collaboration and partnership in research for not only seeking funds, but also in complementarity of work in a consortium mode.

A. Ramakrishna, NARI, PNG, also reiterated the need for a functional definition of UUCs. He supported the network approach in R&D of UUCs for increasing efficiency of output and mobilization of funds. He said that enabling policy environment was much required for making an impact, and strategies should be developed to make UUCs visible to users and policy makers. APAARI should facilitate knowledge management, database development on crops and experts. To make it attractive for researchers Centres of Excellence need to be established. Pro-poor value chains need to be developed, as also encourage custodian farmers and landscapes rich in NUS. Public-private partnerships would be critical in all these endeavours.

Max Herriman, CFF, Malaysia, emphasized that a status report on UUCs needed for their promotion. In addition, peer-reviewed papers also need to be published for awareness. He said that varied stakeholders need to be taken on board and policy matters be addressed accordingly. In terms of developing value chains and markets for UUC products, there was need to understand whether consumers were available outside the local niche of the region where these crops are found. He pointed out that the NUS/UUC should be promoted at 'nutricrops' that could address the SDG 3 targeted at nutritional security.

Plenary Session

Co-Chairs	: <i>Raj Paroda</i> , TAAS, India
	: <i>Yusuf Zafar</i> , PARC, Pakistan
Rapporteur	<i>Rishi Tyagi</i> , APAARI, Thailand

The session commenced by presentation of major recommendations from each of the sessions by the respective rapporteurs. The deliberations held during the three-day meeting brought forth many important issues in the form of suggestions and recommendations, which were briefly summarized by the rapporteurs. It was unanimously agreed that working with UUCs would address SDGs in culminating, hunger, poverty alleviation, and improving good health and well-being, besides attaining sustainable production and consumption, climate change and sustainable use of ecosystems. There was also unanimous agreement for 'functional definition' of UUCs at global and national levels. A holistic rather than reductionist approach to mainstream UCCs with major crop, cropping patterns, seed production, *etc.* needs to be adopted. Consensus emerged that policy makers should be approached to give due attention, generate political will and mobilize funding and subsidies, to promote greater use of these plants. Of course, this would require a comprehensive knowledge sharing system on crops, experts, centres of excellence for capacity building, networking and multi-stakeholder partnerships. Another requirement would be facilitation of germplasm exchange, along with collecting, characterization and evaluation. For this, a global funding system for scholarships, exchange, projects need to be given emphasis, along with awareness generation programs. The meeting proved to be useful to develop future collaborative programmes.

More than 40 nutritionally rich crops such as African Nightshade (β -carotene, calcium, iron, folate, vitamin E and protein), seabuckthorn (vitamin C, E, K, A and omega fatty acids), Peach palm (fiber, vitamins C, E, A, B, and K; minerals K, Ca, Fe, Mg, P, and Zn), moth bean (lysine, leucine, carotene and protein), maca (fiber, I, Ca, P, Zn, Mg, Fe, vitamins B1, B2, B12, C, and E and glucosinolates) and faba bean (Ca, Mg, Fe, and Zn, vitamins B-complex, C, and A) were subject of discussion. Some of the future crops that have potential to cure diseases and improve health were also discussed that include bitter melon (cancer, diabetes, high blood pressure), nana (skin infections, gastrointestinal disorders, and fever), utazi (diabetes) and Nigerian pumpkin- ugu leaf (diabetes, gastrointestinal disorders and support to lactating women). These future crops have climate resilience and potential for livelihood of the people in the APR.

After presentations of reports of the technical sessions by respective Rapporteurs, the Chairman invited the co-organizers to make their remarks. He informed that Vincent Lin, COA, had to leave early and not available for his remarks, however, Vincent Lin assured the full cooperation from COA to implement the recommendations of the meeting with regard to UUCs.

Fenton Beed, WorldVeg Centre, mentioned that the Expert Consultation was an awakening meeting which was represented by almost all experts in the region who participated actively in the deliberations. He appreciated APAARI's efforts to organize it timely and very efficiently with huge success. WorldVeg would look forward to be an active partner for any initiative on UUCs. WorldVeg is also thankful to APAARI for giving an opportunity to be a co-organizer of this meeting.

Hari D. Upadhyaya, ICRISAT, appreciated the efforts of APAARI for meticulous organization of the event. He mentioned that UUCs with low-inputs are the crops of 'voiceless people' – the farmers of tribal areas. He emphasized that the information on research and development outputs should be disseminated amongst the farmers. Several germplasm of these crops have great potential to be released as varieties directly, therefore, evaluation of germplasm in different locations is important to identify the promising germplasm for varietal release as ICRISAT has released about 104 germplasm lines of millets in the form of varieties in 51 countries. He reiterated that all the germplasm available in ICRISAT of millets are available for any researcher for R&D purposes. He mentioned that ICRISAT will support any initiative taken for R&D on millet crops.

Ashutosh Sarker, ICARDA, mentioned that ICARDA management is pleased to work with APAARI as a technical partner of this meeting and also grateful to APAARI for organizing a very successful meeting. He

suggested that APAARI may facilitate (i) the exchange of germplasm in the region and (ii) identification of common UUCs across the region for R&D. He assured full support of ICARDA to APAARI for implementation of programmes on UUCs.

Max Herriman, CFF, expressed his gratitude to APAARI for organizing such an important event with fruitful discussion. He emphasized that UUC needs to be cultivated for minimizing the risk by broadening the horizon of food crops as dependency on a few crops poses a great risk to food and nutritional security. These crops will have greater impact on agricultural landscape in the wake of climate change as wide arrays of crops can be chosen to meet the nutritional requirement. Association of International Research and Development Centers for Agriculture has developed Global Plan of Action for agricultural diversification. CFF will extend all supports to APAARI for critical delivery to meet SDG #17 *i.e.* partnership.

Jai Chand Rana, Bioversity International, thanked APAARI to provide him the opportunity to participate in deliberations on UUCs. Since UUCs are very much befitting in the mandate of Bioversity, therefore, any efforts for mainstreaming the genetic diversity of UUCs in partnership mode is a welcome step to be supported by Bioversity. He also suggested that policies for promotion of UUCs be framed which suits the smallholder farmers in the region.

Ravi Khetarpal, APAARI, informed that APAARI is working in the framework of SDG #17 *i.e.* partnership which required more attention to upscaling it. APAARI has a program namely, APCoAB and scope of APCoAB has been expanded by including 'Bioresources' also to take care of the activities on bioresources including UUCs. APAARI works in collaboration with NARS of member countries to harness maximum synergies through partnership and networking. From operational angle, he suggested to identify a champion on UUCs in each NARS for effective communication by APAARI in future. He profusely thanked all the participants for a fruitful deliberation during the meeting. He assured that with the support of APAARI members and participants, APAARI is committed to carry forward the recommendations of the Expert Consultation.

Yusuf Zafar, PARC, thanked Raj Paroda, Chairman, TAAS, for his guidance to organize the Expert Consultation and chairing the Plenary Session. He asserted that TAAS, APAARI has made good beginning to organize this meeting on UUCs as APCoAB scope is expanded to include the activities on bioresources, since UUCs are very impactful for addressing the nutritional security issues. He emphasized to promote cultivation of UUCs, prioritization of crops in each country with proper market linkages are very important. SIDs need technological support and support for capacity building for realizing the social impacts in these countries. APAARI may facilitate the process in relation to UUCs in SIDs. He mentioned that proceedings of the deliberation will be published by APAARI and will be shared with all stakeholders, including policy makers, to harness the maximum potential of UUCs.

Raj Paroda, TAAS, and Chairman of Plenary Session expressed his satisfaction for organization of this meeting by APAARI in very structured manner, which served the purpose to draw much needed attention of all stakeholders towards UUCs. He mentioned that Expert Consultation is timely organized, in view of adaptation to climate changes and ensuring nutritional security by diversification of our food basket by promoting the cultivation of UUCs. He also stressed for prioritization of the crops at national, sub-regional and regional levels and identify the niches/ecoregions for promoting these crops to meet SDGs and realize the social impacts. Partnership, networks and greater investments are critical for promoting the UUCs. Earlier networks *e.g.* CLAN may be revived and if needed new networks may also be established. He mentioned that APAARI and CFF may facilitate the revival and establishment of the networks in the region. For enhancing the investments, proposals at national and sub-regional levels may be developed which may be submitted to funding agencies like Bill and Melinda Gates Foundation, FAO, and UNEP. He reiterated that capacity development through creating 'Centers of Excellence' needs more attention at the moment. He reposed the confidence in APAARI to facilitate the above activities on UUCs at regional level.

Rishi Tyagi, APCoAB, APAARI proposed a vote of thanks to Co-Chairs, Rapporteurs, Facilitators, all the participants and all staff members of APAARI. On behalf of APAARI and on his own behalf, he expressed sincere gratitude to all the co-organizers and co-sponsors of Expert Consultation for their generous financial and technical contributions.

Major Recommendations

Research and Education

- Genetic resources of UUCs in the APR should be mapped and a baseline database be developed on species and diversity, to enable preparation of a comprehensive status report on these plants. APAARI may take a lead in collaboration with NARS, CABI, CFF, CGIAR and other relevant institutes in respective regions.
- Documentation and validation of indigenous/traditional knowledge/ethnobotany, culinary recipes and local uses of UUCs, should be undertaken on priority. A web-based encyclopedia may be established for collating all such published information (e.g. Global Knowledge Base for UUCs, for diversification of agriculture by CFF).
- PGR management of UUCs should be given greater thrust for survey, collecting, characterization and evaluation (nutritional and health). For holistic conservation, facilities (*in situ*, on-farm, *ex situ*, field genebank, *in vitro*, cryopreservation) for these plants need to be strengthened. Equally important is facilitation of germplasm exchange among countries in the APR. For this, an assured funding system needs to be established, both at national and regional level.
- Research for developing good multiplication protocols and agricultural practices to get better production, enhancing the efficiency of hybridization techniques in small millets, pseudocereals and grain legumes, evolving varieties for specific end-uses and increased health benefits, improved quality for higher income, breeding region-specific, high yielding, stress tolerant varieties that do not have anti-nutritional factors commonly associated with some UUCs, development of technologies to manage important pests and diseases during production and storage, development of cost-effective processing technology and improvement of shelf life, are the priority areas in agronomy and breeding. Bioprospecting UUCs to develop novel products is another important area which needs to be given priority attention.
- School, college and university curricula should include information about UUCs which needs to be given priority attention to raise awareness about their importance among the youth. A global/regional/national funding system for scholarships, exchange, projects targeting UUCs would ensure more research output in these plants.

Development

- A holistic rather than reductionist approach to mainstream major UUCs cropping patterns, seed production, *etc.* should be adopted. A value chain that spans genetic resources to potential markets for particular UUCs at any location needs to be developed. Primary production of UUCs requires availability of quality seed, and private sector should be engaged for this purpose.
- While mainstreaming UUCs, it is important to keep in view the information from the demand side. Development of competitive and sustainable agro-food industry, increase of income of agricultural entrepreneurs, raising awareness of the consumers and farmers about nutrition and cultivation of UUCs, lack of adequate government support for marketing of UUCs and promotion in international market, insufficient planting material of herbs and medicinal plants are some challenges which need to be addressed.
- Issues of supply chain (procurement, bulking, aggregation, storage and processing) need to be studied. Supporting local food chains and establishing local processing industries and linking with eco-tourism, organic trades, hospitals and school feeding programs are areas requiring attention.
- Promoting custodian farmers for effective conservation and sustainable utilization, developing value chain and market support, and popularizing family nutrition garden involving women self-help groups, are pathways for long-term sustainable development, need to be paid greater attention.
- There is need for creating investment opportunities for collaborative R&D, and marketing linking to agro-tourism and processing to enhance promotion of UUCs.
- Mass media (TV, internet, celebrity endorsements), technology parks/incubator parks and food festivals in PPP mode needs to be promoted for awareness generation, promotion and marketing.

Policy

- A 'functional definition' of UUCs at global, regional and national levels is urgently required. An expert committee may be formed to develop a document to bring about synergy amongst various countries for classification of this group of plants.
- As cultivation and use of UUCs would address the SDGs of ending hunger, poverty alleviation, and for good health and well-being, sustainable production and consumption, climate change and sustainable use of ecosystems, governments need to accord adequate attention, priority and funding for its development and mainstreaming.
- 'Steering Committees' needs to be constituted at national level comprising policy makers (e.g. Ministry or Department of Agriculture), researchers, NGOs/NPOs, private industry players (especially for value addition) and farmer's representatives.
- The Steering Committees should coordinate R&D activities at national level and make policy decisions on behalf of the government, besides monitoring fund allocation. 'Working Groups' and 'Technical Groups' may be established at national and regional levels. The Chairs of these working groups should be members of the Steering Committees to develop a national policy on UUC/NUS.
- Policy based interventions like food subsidy, cultivation subsidy and promotion of government food schemes (e.g. mid-day meals, promotion of multi-grain flour, *etc.*) would significantly promote UUC/NUS, and address the welfare of the poorest of the poor.

Regional Cooperation and Networking

- It was unanimously agreed that strong partnership between IARCs, NARS, Universities, Regional Networks, NGOs, NPOs, Scientific Societies and Farmers Groups is required to strengthen work on UUCs. Sharing of information among and between these stakeholders can be done by development of databases on crops, experts and research activities at national level, and focal institutes should be identified in each country.
- A Centre of Excellence, with necessary expertise on UUCs, may be established for capacity building, networking and multi-stakeholder partnerships. Research institutes and Universities may be utilized to develop competencies and skills. Collaborative research programmes should be developed to enhance capacity and skills.
- Knowledge management system needs to be developed at regional level may be established and it may be facilitated by APAARI.
- Bilateral or regional cooperation/networking may be developed for efficient and effective germplasm exchange and exploration.
- Capacity building, especially for *in vitro*, cryo and molecular techniques at regional level is required, especially in the Pacific regions. Further, capacity building of farmers is required for marketing of produce and products of UUCs.

Action Points for APAARI

APAARI through activities of its APCoAB programme needs to make efforts to take certain actions on priority to enhance the use of UUCs through research, knowledge management and capacity building programmes in discussions and partnerships with NARS and other related agencies. Funding for the activities need to be explored. Strengths of international organisations (CFF, CGIAR, WorldVeg, CABI, *etc.*) and interested universities be explored as partners while submitting funding proposals. Consultants be engaged to develop the proposals.

Funding for the activities need to be explored. Strengths of international organizations (CFF, CGIAR, WorldVeg, CABI, *etc.*) and reputed international universities to be explored as partners while submitting funding proposals. Consultants may be engaged to develop the proposals.

1. **Facilitate establishment of web-based open source Knowledge Portal of Potential UUCs for APR:**
A Knowledge Portal needs to be developed which shall have all published information on aspects of potential UUCs relevant to the region. It is inclusive of species identity including photos/videos; natural occurrence; genetic resources information on collection and evaluation gaps; access and conservation status; current status of cultivation; value chain; profitability; seed systems status; package of practices; supply chain; markets; food, nutrition, health and ecosystem services for each crop and country in searchable format. Knowledge Portal may be hosted by APAARI which shall be maintained and updated at a regular interval. It shall also have scope for capacity building opportunities in the form of MOOCs or other certification process preferably in major languages relevant to the needy member countries.
2. **A Centre of Excellence for Research and Development on UUCs:** Establishment of this COE could be in project mode with partners from within and outside APAARI to initiate and strengthen Research and Development on prioritized crops addressing 12 of 17 SDGs that have indicators reflecting nutrition role in sustainable development. The major aim of this COE will be to develop local and NARS capacities in R&D of UUCs.
3. **Seed Systems and Markets for UUCs:** Initiate, strengthen and support seed systems for UUCs to expand their cultivation area, production and productivity. Major goals of this project shall be access to quality seeds involving formal and informal seed systems, including involvement private seed industry. Market intelligence cell shall strive to link and promote relevant crops and value-added products.
4. **Develop Policy Briefs:** These briefs shall be relevant to the country. Priority may be given to the countries that are severely affected by malnutrition. Develop the briefs involving public, private and community organizations realizing the sensitivities and practicality so that follow up action is responsibility of the respective countries with the help of APAARI wherever needed.

Some Specific Action Points for Members of APAARI

Networks or Network projects development with available resources or through external funding is recommended. Major aim of these action points is sharing of learning experiences, germplasm, value addition and even varieties/hybrids among the member countries. APAARI should facilitate legitimate exchange of knowledge and resources through MTAs following the international obligations. Option shall be open to any member country to be the part of network. However, conditions can be laid down by an independent committee regarding contributions needed to be member of the Network. Following action points were suggested:

- Develop network for millets with ICRISAT as lead organization and India as Lead Country, for underutilized vegetables and fruits with WorldVeg as lead organization and Malaysia/Thailand as Lead Country, grain legumes and underutilized pulses with Sri Lanka as Lead Country, for tubers and ethnic leafy vegetables with PNG as lead country.
- Publish Case Studies in detail on Tropical Fruit Diversity UNEP GEF experience and commercialization of *Phyllanthus watsonii* from Malaysia; Commercialization of passion fruit from Lao PDR, Herbal Remedies Case from Sapanapro & Red Dao community and Seed Systems (Community Managed Seed Systems) from India.

Appendix I

Participants

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Appendix II

Inaugural Address

Outlook of Global Food Security and the Role of Underutilized Food Resources

Hiroyuki Konuma



Hiroyuki Konuma (Ph.D.)

Professor and the Director of Meiji University ASEAN Center, Bangkok Thailand & Former Assistant Director-General and Regional Representative of United Nations (UN) Food and Agriculture Organization

Hiroyuki Konuma, a Japanese national, born in Tokyo in 1953, is a graduate of Meiji University (Agricultural Chemistry) and holds M.Sc. and Ph.D. in Agricultural Science from University of Tsukuba in Japan. In addition to his responsibilities as Director, Meiji University, he is also teaching at Srinakarinwirot University in Thailand as a Visiting Professor. He had been an official of the United Nations (UN) FAO for nearly 35 years. He started his professional carrier in Syria with JICA (JOCV) in 1977 as a Junior Expert in Animal Husbandry. He joined UN/FAO in 1980 in Yemen as an Associate Expert in animal husbandry. He moved to Somalia as the Head of UNHCR Field office in Jalalaqsi in 1983 and engaged in refugee agricultural settlement programme. He returned to FAO in 1985 and posted in Ghana (4 years), FAO HQs in Rome (7 years) and Bangladesh (4 years), and was transferred in 1999 to FAO Regional Office for Asia and the Pacific in Bangkok, Thailand. He was appointed as the FAO Assistant Director General and the Regional Representative for Asia and the Pacific in March 2010, and managed FAO Regional Office in the area of agriculture (including crop, livestock, forestry and fisheries), agricultural policy, food security, nutrition, rural development and other associate fields. He also acted as FAO representative for Thailand. He retired from the United Nations FAO in July 2015, and joined Meiji University, Japan as a Professor in April 2016.

Professor and the Director of ASEAN Center, Meiji University, Japan and the former FAO ADG and Regional Representative for Asia and the Pacific Region

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Dr Yusuf Zafar, Chairman APAARI, Dr Raj Paroda, Chairman TAAS, Dr Ravi Khetarpal, Executive Secretary APAARI, Dr Vincent Lin, Deputy Director-General of the Council of Agriculture (COA), Dr Suwit Chaikiattiyos, Director-General of Department of Agriculture (DOA), Government of Thailand, Dr Fenton Breed, Regional Director, World Vegetable Center, representatives from ICRISAT, ICARDA, CFF and other concerned organizations, distinguished guests, scientists, ladies and gentlemen!

First of all, I wish to express my special gratitude to APAARI and COA for inviting me to this important gathering. I feel very honored to deliver an inaugural address in front of many well-known senior scientists and policy makers gathered here today.

Indeed, the topic of this expert consultation '**Underutilized Crops for Food Security and Nutrition**' is also my life time research subject, with a great scientific interest in view of the high potential of underutilized crops towards achieving food security and better nutrition.

Present status of food security and nutrition

Ladies and gentlemen, this expert consultation is organized very timely as a decade long declining trend of both number and proportion of chronically undernourished population in the world as well as in Asia have started to reverse the direction to increasing trend, which was announced just recently by the United Nations. Indeed, according to the UN report (The State of Food Security and Nutrition in the World, published by FAO and associated UN Agencies on September 15, 2017), in 2016, the number of chronically undernourished people in the world would have increased to 815 million, up from 777 million in 2015 (Fig. 1, 2). In case of Asia, it increased to 520 million from 508 million during the same period. This shocking news was released against our continued efforts, and despite the global commitment made just last year to eradicate hunger by 2030 under the Sustainable Development Goals (SDGs).

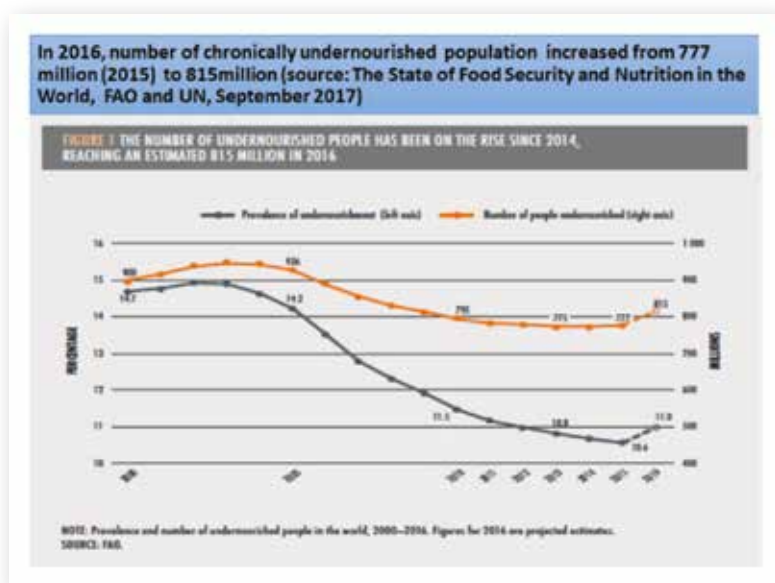


Figure 1. The number of undernourished people has been on the rise since 2014, reaching an estimated, 815 million in 2016

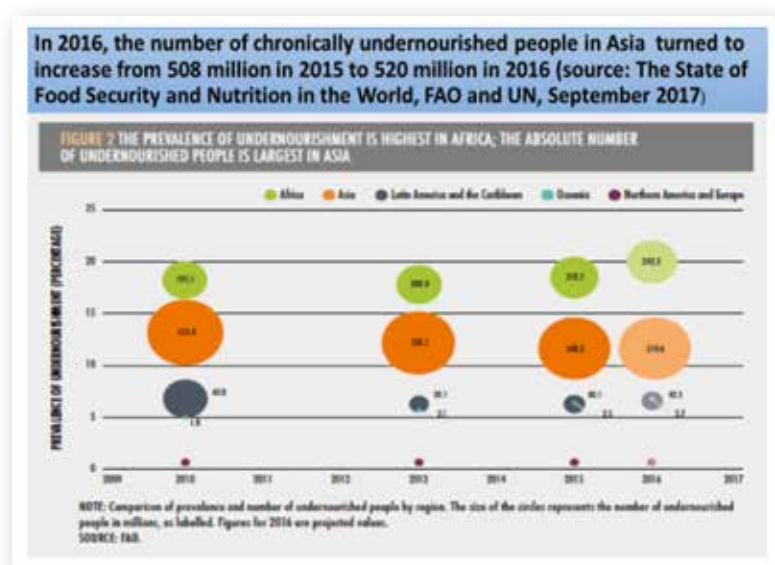


Figure 2. The prevalence of undernourished is highest in Africa; The absolute number of undernourished people is largest in Asia

According to the UN report, these are driven by increasing conflicts and climate related shocks. Over the past decade, conflicts have increased dramatically and become more complex. More than a half of 815 million chronically undernourished people live in conflict affected countries (Fig. 3). Famine in South Sudan lasted for several months in 2017, and there is a high risk of famine in other conflict-affected countries such as Nigeria, Somalia, Yemen and potentially in Afghanistan and DPR Korea.

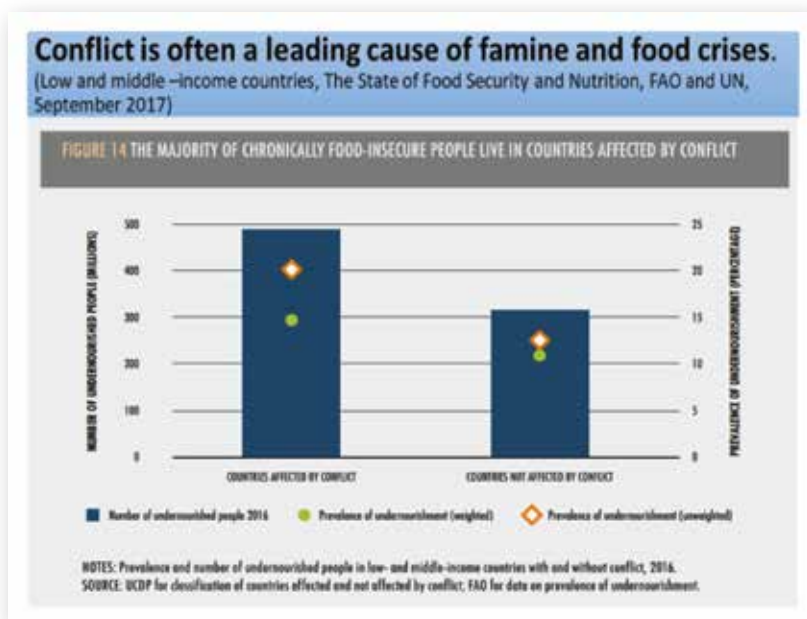


Figure 3. The majority of chronically food-increase people live in Countries affected by conflict

Climate related shocks can even occur suddenly without conflict situation in form of droughts or floods or other extreme weather events, often linked to the El Niño. The Intergovernmental Panel on Climate Change (IPCC) report in 2014 indicated that there would be a high risk of occurrence of extreme weather events, if we failed to manage surface temperature increase to less than 2 centigrade by 2100 (Fig. 4). However, recent IPCC report said that even if we successfully meet the target of the deduction of Green House Gas emission agreed in Paris last year, we would only be possible to achieve 3 centigrade increase level by 2100. If this is the case, it would likely be resulted in higher rise of sea water level and consequent decline of agricultural lands especially in fertile lowland and delta areas, increase in plant pests and animal diseases.

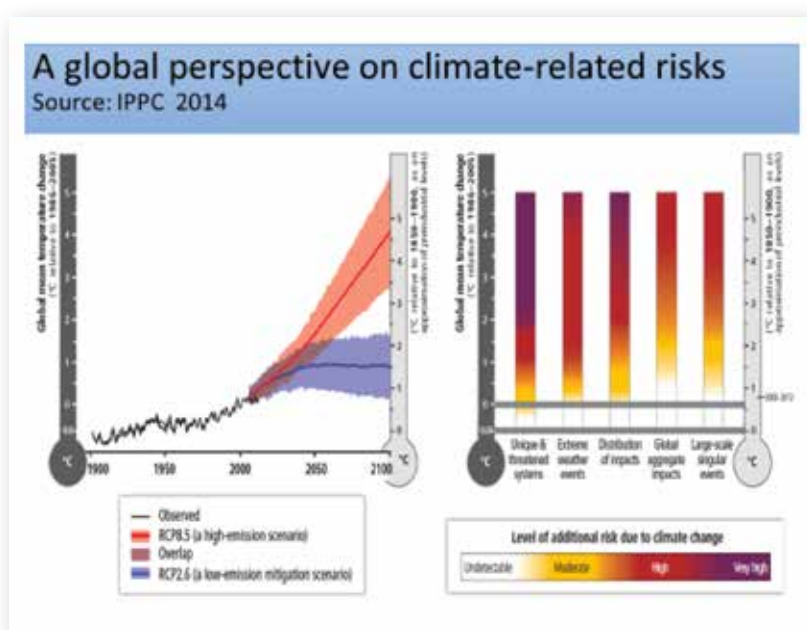


Figure 4. A global perspective on climate-related risks

Furthermore, as estimated by IPCC, if we continue business as usual in emitting Green House Gas, crop yields would be affected negatively, especially in developing countries. Such yield deduction might be accelerated in high speed after 2030. This means that present impact of climate related shocks which is considered as one of the main causes of the increase of chronically undernourished people in 2016, might be a just alarming signal before real deeper problem may actually start beyond 2030 (Fig. 5).

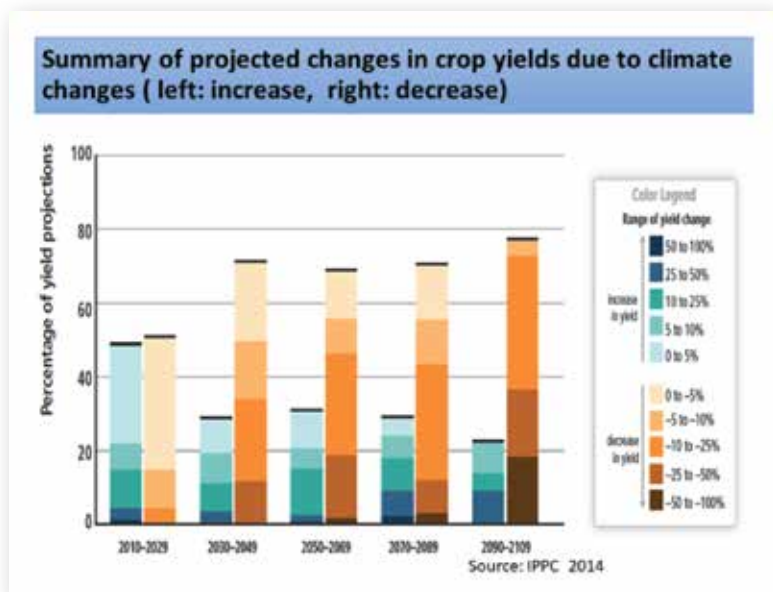


Figure 5. Summary of projected changes in crop yields due to climate changes (Left:increase, right:decrease)

The same report said that some 155 million children aged under five are stunted (too short for their age), while 52 million suffer from wasting (meaning their weight is too low for their height). An estimated 41 million children are now overweight. The United Nations Children's Fund (UNICEF) report indicated that about three million children below age 5 die every year due to nutrition related diseases. About 33 per cent of the total reproductive age of women (613 million) are affected by anaemia and 13 per cent of all adults (641 million) are suffering from obesity. FAO estimated that about 2 billion people are suffering from micro-nutrient deficiency due to lack of sufficient intake of vitamins and minerals.

Future outlook towards 2050

Population and consumption increase

The question is what is the food requirement to meet the needs of growing population and what is the future prospect of the production and challenges to ensure food security for our children and future generations. One of the current UN projections indicated that world population could increase by more than 2 billion people from today's level, reaching around 9.3 billion by 2050. Incomes and per capita calorie intake will grow even faster. According to FAO's estimate, by 2050, some 52 per cent of the world's population may live in countries where average calorie intake is more than 3,000 kcal/person/day, while the number of people living in countries with an average below 2,500 kcal may fall from 2.3 billion to 240 million (FAO, 2015).

World needs 60 per cent food production increase by 2050

To meet rapidly increasing combined food demand from both population growth and per capita food consumption increase, FAO projects that global agricultural production in 2050 would have to 60 per cent higher than that of in 2005/2007 if the world is going to satisfy food requirement at that time.

Agricultural research is the key for achieving future food security

According to a FAO study, most of the increase in production (nearly 90 per cent) leading up the year 2050 (from 2005/2007 to 2050) is expected to derive from improved yields through agricultural research. Some gains would also come from higher cropping intensity, predominantly in developed countries, and

about 5 per cent increase (70 million ha) from the expansion of arable land, mainly from developing countries in Africa and Latin America.

Future challenges and uncertainties

While it might be possible to increase food production by 60 per cent by 2050, if the above assumptions and pre-requisites are met, there would be a number of serious challenges and uncertainties such as stagnation of the expansion of arable land which is almost fully exploited in Asia, advancing water scarcity, especially where water is most needed, stagnation of productivity growth of major staples, decline in agricultural investment, competition between food crops and bio-energy crops on the use of limited natural resource base, and negative impact of climate changes.

Value of underutilized food crops towards promotion of food security

Biodiversity and food security

Ladies and gentlemen,

As you are aware, conservation and sustainable use of biodiversity for food and agriculture play a critical role in the fight against hunger, by ensuring environmental sustainability while increasing food and agriculture production. Despite the importance of biodiversity, the declining number of species upon which food security and economic growth depend, has placed the future supply of food and rural incomes at risk. The shrinking portfolio of species and varieties used in agriculture reduces the ability of farmers to adapt to ecosystem changes, new environments, needs and opportunities.

About 7,000 species of plants have been cultivated for consumption in human history. The great diversity of varieties resulting from human and ecosystem interaction guaranteed food for the survival and development of human populations throughout the world in spite of pests, diseases, climate fluctuations, droughts and other unexpected environmental events. Presently, only about 30 crops provide 95 per cent of human food energy needs, four of which (rice, wheat, maize and potato) are responsible for more than 60 per cent of our energy intake. Due to the dependency on this relatively small number of crops for global food security, it will be crucial to maintain a high genetic diversity to deal with increasing environmental stress and to provide farmers and researchers with opportunities to breed for crops that can be cultivated under unfavourable conditions, such as dry lands, wetlands, swamps, saline soils, and tolerant to extreme weather conditions (FAO Biodiversity, 2014).

Uncertainty in future food security

As explained earlier, there has been growing global concern of the serious food security challenges and uncertainties in coming decades, which may further impact world peace and stability, if sufficient foods are not produced to satisfy future global needs, especially for poor people. On the other hand, globalization has created homogeneity of food resources, accompanied by a loss of different culinary traditions and agricultural biodiversity, and created negative consequences for ecosystems, food diversity and health. Accordingly, FAO has stressed the importance of neglected and underutilized species which would play a crucial role in the fight against hunger, and called for increased research on underutilized food resources especially those produced on poor and underutilized lands (wetlands, swamps, saline soil, etc.) by the poor.

Value of underutilized food crops

Many neglected and underutilized species are adapted to low-input agriculture and contains high vitamins and minerals which are crucial for solving child under nutrition. The use of these species - whether wild, managed or cultivated, can have immediate consequences on the food security and well-being of the poor. Dr. Graziano da Silva, the Director General of FAO stressed at an international seminar held in Spain in December 2012 that neglected and underutilized species play crucial role in the fight against hunger and are a key resource for agriculture and rural development. He called for increasing research on underutilized crops for the benefit of smallholder farmers. In addition, many neglected and underutilized species play a role in keeping cultural diversity alive. They occupy important niches, conserving traditional landscape, adapted to the risky and fragile conditions of rural communities.

For example, sago palm (*Metroxylon sagu* Rottb.) is one of the typical underutilized indigenous food crops in Asia and the Pacific Region, with very little attention and research in the past (Fig. 6). It can be grown in underutilized wetlands and peat swamps where other food crops cannot be grown economically and produce high yields of starch (150-300 kg of dry starch per plant). Thus, sago palm has a high potential to contribute to food security as an additional source of staple foods without (or less) competition on the use of arable land with other food crops. Sago starch, if mixed with 60 per cent of wheat flour, can be used for making breads and noodles without compromising the original taste and quality of wheat flour. Hence, sago starch would contribute in increasing the volume of edible starch available in food market. Unfortunately, sago palm tree population has drastically decreased in the recent past due to the conversion of sago growing wetlands and swamps for other purposes including the expansion of industrial crops such as oil palm and rubber trees, which were more profitable to farmers. There has been a lack of clear recognition of the value of sago palm, and a lack of policy and financial support by the government.

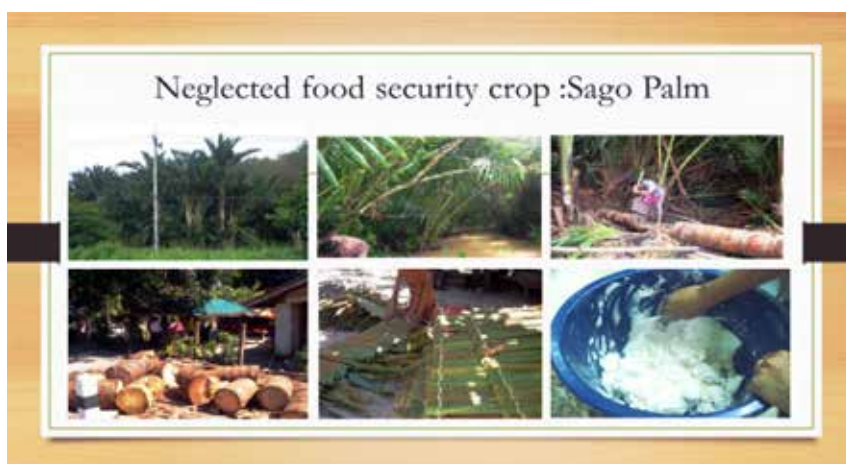


Figure 6. Neglected food security crop: sago palm

Conclusion

In conclusion, it became clearer that the world is facing greater uncertainties in coming decades in achieving food security and nutrition. Role of underutilized crops which were adopted socially and environmentally in local conditions, survived for centuries under changing climate conditions, and contributed to poor rural communities should be fully promoted as a contributor to food security and nutrition. It would require a strong advocacy, policy support, research and development effort, and resource allocation.

I wish a very successful expert consultation and fruitful outcomes.

Thank you!

Appendix III

Technical Programme

Day 1: Monday, 13 November 2017

08:30-09:00	Registration	
Opening Session		
09:00-09:07	Welcome Address	Ravi Khetarpal, APAARI, Thailand
09:07-09:14	Setting the Context	Raj Paroda, TAAS, India
09:14-09:21	Remarks	Vincent Lin, COA, Taiwan
09:21-09:28	Remarks	Suwit Chaikiattiyos, DOA, Thailand
09:28-09:35	Remarks	Fenton Beed, WorldVeg, Thailand
09:35-09:42	Remarks	Yusuf Zafar, APAARI, Thailand
09:42-10:00	Inaugural Address	Hiroyuki Konuma, Meiji University, Thailand
10:00-10:05	Vote of Thanks	Rishi Tyagi, APAARI, Thailand
10:05-10:30	Tea/Coffee Break and Group Photograph	

Technical Session I: Thematic Technical Presentations

Co-Chairs : N.K. Krishna Kumar, Bioversity International, India and K.S. Varaprasad, Ex ICAR, India
 Rapporteur : Umesh Srivastava, Ex ICAR, India

10:30-10:50	Underutilized Crops for Food and Nutritional Security: Global Scenario	Benard Ngwene, Leibniz institute, Germany
10:50-11:10	'Crops for the Future': Agricultural Diversification to 2017 and Beyond	Max Herriman, CFF, Malaysia
11:10-11:30	Underutilized Plant Diversity in Asia and the Pacific	Anjula Pandey, NBPGR, India
11:30-11:50	Grasspea: A neglected but Important Pulse Crop for Nutritional Security of low-income People	A. Sarker, ICARDA, India
11:50-12:10	Nutritionally Rich Underutilized Vegetables	Ray-yu Yang, WorldVeg, Taiwan
12:10-12:30	Edible Wild Plants in Asia-Pacific: A Case Study with Bastar Tribal Pockets	Umesh Srivastava, Ex-ICAR, India
12:30-12:50	Biofortification using Underutilized Crops	Binu Cherian, Harvestplus, India
12:50-13:10	Knowledge Management Resources in CABI for Underutilized Crops	A. Sivapragasam, CABI, Malaysia
13:10-14:00	Lunch at Iris Restaurant, Rama Gardens Hotel	
14:00-14:20	Forecast Application for Risk Management in Agriculture: Case Study from Tamil Nadu, India	Anshul Agrawal, RIMES, Thailand
14:20- 14:40	Discussion	

Technical Session II

Strategies on Underutilized Crops for Food and Nutritional Security

Co-Chairs : Darab Hassani, AREEO, Iran and Ray-yu Yang, WorldVeg, Taiwan

Rapporteur : K.S. Varaprasad, Ex ICAR, India

14:40-14:55	Pseudocereals (grain amaranth, buckwheat, chenopods)	Kuldeep Singh, NBPGR, India
14:55-15:10	Unterutilized Climate-smart Nutrient Rich Small Millets for Food and Nutritional Security	H.D. Upadhyaya, ICRISAT, India
15:10-15:25	Unterutilized Legumes: Global Status, Challenges and Opportunities for Harnessing Potential Benefits	J.C. Rana, Bioversity International, Central and South Asia Office, India
15:25-15:40	Tea/Coffee Break	
15:40-15:55	Importance of Tuber Crops for Food and Nutritional Security in Oceania	Arshni S. Shandil, SPC, Fiji
15:55-16:10	Unterutilized Tropical and Sub-Tropical Fruits for Nutrition and Health Security and Climate Resilience – A Biodiversity International Initiative	N.K. Krishna Kumar, Bioversity International, Central and South Asia Office, India
16:10-16:25	Potential of Seabuckthorn (<i>Hippophae L.</i>) – A Multipurpose Under-utilized Crop of Dry Temperate Himalayas	Virender Singh, CSKHPKV, India
16:25-16:45	Discussion	

Technical Session III: Country Status Reports on Underutilized Crops

Co-Chairs : Mohamad Roff, MARDI, Malaysia and A. Sarkar, ICARDA, India

Rapporteur : Anjula Pandey, NBPGR, India

South Asia		
16:45-17:00	Bangladesh	Rina Rani Saha, Bangladesh
17:00-17:15	Bhutan	Kailash pradhan, Bhutan
17:15-17:30	India	Kuldeep Singh, India
17:30-17:45	Iran	Darab Hassani, Iran
17:45-18:00	Sri Lanka	Hemantha Wijewardena, Sri Lanka
18:00-18:15	Nepal	Baidya Nath Mahto, Nepal
18:15-18:30	Pakistan	Abdul Ghafoor, Pakistan
18:30-18:50	Discussion	
19.00	Reception Dinner at Iris restaurant, Rama Gardens Hotel	

Day 2: Tuesday, 14 November 2017

Special Session

Co-Chairs: Ravi Khetrapal, APAARI, Thailand and H. Wijewardena, SLCARP, Sri Lanka

Rapporteur: Anuradha Agrawal, NBPGR, India

09:00-09:20	Women Farmers as Driving Force	Eri Otsu, Heroines for Environment and Rural Support (HERS), Japan
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Technical Session III: Country Status Reports on Underutilized Crops (contd.)

Co-Chairs : Fenton Beed, WorldVeg, Thailand and Reynaldo V. Ebor, PCAARRD, Philippines

Rapporteur : Kailash Pradhan, DOA, Bhutan

South East Asia		
09:20-09:35	Lao PDR	Bounthong Bouahom, Lao PDR
09:35-09:50	Malaysia	Mohamad Roff Bin Mohd. Noor, Malaysia
09:50-10:05	Thailand	Nuengruethai Srithornrath, Thailand
10:05-10:20	Vietnam	Pham Hung Cuong, Vietnam
10:20-10:35	Philippines	Reynaldo V. Ebor, Philippines
10:35-10:50	Taiwan	Keng-Chang Chuang, Taiwan
10:50-11:10	<i>Discussion</i>	
11:20-11:30	<i>Tea/Coffee Break</i>	

Technical Session III: Country Status Reports on Underutilized Crops (contd.)

Co-Chairs : Bounthong Bouahom, NAFRI, Lao PDR and Kuldeep Singh, NBPGR, India

Rapporteur : Arshni Shandil, SPC, Fiji

The Pacific		
11:30-11:45	Fiji	Savenaca Cuquma, Fiji
11:45-12:00	Papua New Guinea	Birte Komlong, PNG
12:00-12:15	Samoa	Tolo Iosefa, Samoa
12:30-12:45	<i>Discussion</i>	
12:45-14:00	<i>Lunch at Iris Restaurant, Rama Gardens Hotel</i>	

Technical Session IV A: Working Group Discussion

14:00-16:00	<p>Working Group 1 Production: Conservation, Improvement and Crop Management</p> <p>Chair : H.D. Upadhyaya, ICRISAT, India Facilitator : K.S. Varaprasad, Ex ICAR, India</p>
	<p>Working Group 2 Utilization: Value addition, Marketing and Export</p> <p>Chair : Dhruvad Chowdhury, ICIMOD, Nepal Facilitator : J.C. Rana, Bioversity International, Central and South Asia Office, India</p>
	<p>Working Group 3 Partnership and Capacity Building</p> <p>Chair : Mohamad Roff Bin Mohd. Noor, MARDI, Malaysia Facilitator : Anuradha Agrawal, NBPGR, India</p>
	<p>Working Group 4 Biotechnology for Enhancing Utilization of Underutilized Crops</p> <p>Chair : Rajeev Varshney, ICRISAT, India Facilitator : Rishi Tyagi, APAARI, Thailand</p>
16:00-16:20	<i>Tea/Coffee Break</i>

Technical Session IV B: Working Group Recommendations

Co-Chairs : Birte Komlong, NARI, PNG and B.N. Mahto, NARC, Nepal
Rapporteur : Anjula Pandey, NBPGR, India

16:20-16:25	Working Group 1	H.D. Upadhyaya, ICRISAT, India
16:25-16:30	Working Group 2	Dhruvad Choudhury, ICIMOD, Nepal
16:30-16:40	Working Group 3	Anuradha Agrawal, NBPGR, India
16:40-16:45	Working Group 4	Rajeev Varshney, ICRISAT, India
16:45-17:00	<i>Discussion</i>	

Day 3: Wednesday, 15 November 2017

Technical Session V: Panel Discussion on Policy Support for Underutilized Crops to Achieve SDGs

Co-Chairs : Max Herriman, CFF, Malaysia and Sergei Bang, NARI, PNG
 Rapporteur : Anuradha Agrawal, India

09.00-11.00	Perception of Panelists (Max.10 min each)
	Yusuf Zafar, PARC, Pakistan
	Fenton Beed, WorldVeg, Taiwan
	Reynaldo V. Ebor, PCAARRD, Philippines
	Kuldeep Singh, India
	Mohammed Roff Bin Mohd. Noor, MARDI, Malaysia
	Rajeev Varshney, ICRISAT
	K.S. Varaprasad, Ex ICAR, India
	Benard Ngwene, Leibniz Institute, Germany
	Ravi Khetarpal, APAARI, Thailand
	Dhrupad Chowdhury, ICIMOD, Nepal
11.00-11:20	<i>Tea/Coffee Break</i>

Plenary Session

Co-Chairs : Raj Paroda, TAAS, India and Fenton Beed, WorldVeg, Thailand
 Rapporteur : Rishi Tyagi, APAARI, Thailand

11.20-12.20	Presentation of Recommendations of Technical Sessions/Working Groups	Umesh Srivastava; K.S. Varaprasad; Anjula Pandey; Arshni Shandil; Anuradha Agrawal
12.20-12.40	Brief Remarks by the Co-Organizers (~2-3 min, each)	Fenton Beed; H.D. Upadhyaya; Max Herriman; A. Sarkar ; N.K. Krishna Kumar; Ravi Khetarpal
12.40-12.55	Remarks by the Co-Chair (7-8 min, each)	Fenton Beed Raj Paroda
12.55-13.00	Vote of thanks	Rishi Tyagi
13.00-14.00	<i>Lunch at Iris Restaurant, Rama Gardens Hotel</i>	

Appendix IV

Organizing Committee

- Senior Advisor:** Dr Raj S. Paroda
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Email: raj.paroda@gmail.com
- Co-Chairs:** Dr Ravi Khetarpal
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- Ms Tarathip Sanboonbrong
Intern, APAARI
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Appendix V

Photo Gallery



Participants of Expert Consultation



Registration of participants



Suwit Chaikiattiyos, DOA and Vincent Lin, COA, Taiwan interacting with each other



Raj Paroda, Hiroyuki Konuma and Suwit Chaikiattiyos (L to R) interacting before inauguration



Inaugural session (L to R) – Vincent Lin, Yusuf Zafar, Hiroyuki Konuma, Raj Paroda, Suwit Chaikiattiyos, Fenton Beed, Rishi Tyagi



Ravi Khetarpal, Executive Secretary, APAARI welcoming Hiroyuki Konuma, Chief Guest



Hiroyuki Konuma, Chief Guest, delivered Inaugural Address



Raj Paroda interacting in technical session



Yusuf Zafar chairing a technical session



Ravi Khetarpal presenting his remarks during opening session



A view of Participants of Expert Consultation



A view of the Participants during Working Group Discussion



Max Herriman, CFF, made presentation on Crops for Future



Ashutosh Sarker, ICARDA, presenting his views on grass pea – a neglected pulse crop



Fenton Beed, WorldVeg, presenting his remarks during inauguration



Rajeev Varshney, ICRISAT, presenting recommendations of Working Group 4



N.K. Krishna Kumar, Bioversity International, making presentation on underutilized tropical and sub-tropical fruits



H.D. Upadhyaya, ICRISAT, discussing about small millets



Some Participants of Expert Consultation



Gender-specific discussion on underutilized crops



Release of book on “Seabuckthorn – a Multipurpose Wonder Plant”



APAARI Secretariate staff supporting the participants by arranging all logistics during Expert Consultation



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