PROMOTION OF UNDERUTILIZED INDIGENOUS FOOD RESOURCES FOR FOOD SECURITY AND NUTRITION IN ASIA AND THE PACIFIC

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PROMOTION OF UNDERUTILIZED INDIGENOUS FOOD RESOURCES FOR FOOD SECURITY AND NUTRITION IN ASIA AND THE PACIFIC

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Foreword

Today, in the world there are almost 842 million people (representing 12 percent of the global population or one out of every eight people) undernourished in terms of dietary energy supply. The situation persists despite the fact that globally there is enough food for all. Further, an estimated 26 percent (about 162 million) of the world's children are stunted, and almost 30 percent of the world's population suffers from one or more micronutrient deficiencies as a result of diets that are deficient in staple and micronutrient-rich foods (e.g. vegetables, legumes, fruit and animal-source foods) that are essential for healthy growth and development. This issue is particularly critical in the Asia and the Pacific region, which accounts for nearly 63 percent of the world's chronically hungry people. According to UNICEF latest report in South Asia, around 39 percent of children under the age of five are stunted, and nearly three-quarters of people with micronutrient deficiencies live in Asia.

At the same time, there are emerging concerns about unhealthy consumption patterns stemming from poor awareness about proper nutrition. Many people consume excessive amounts of sugar and fats, as well as foods with few or no valuable nutrients, which leads to obesity and poor health. Currently there are about 1.4 billion overweight adults worldwide, of which 500 million are obese which increases their likelihood of incurring various non-communicable diseases and health problems including cardiovascular disease, diabetes and various cancers.

The world is expected to produce more food to meet deman of rapidly growing population by 70 percent in developing countries against stagnation of land and water, including against competition between bioenergy and food crops. High volatile food prices affecting specially the poor people who are spending a higher proportion of their limited incomes on their food needs; they are consuming smaller quantities, less frequently; and they are eating cheaper and in many cases, less nutritious foods. While, FAO recognizes that it is possible to achieve food demand through agriculture intensification and improving productivity and agricultural yield, there are other many uncertainties such as impact of climate change. Therefore, different means for achieving food security and nutrition should be explored.

Traditional and indigenous food resources constitute the bedrock of the diversity in traditional and indigenous food systems of communities in developing country. The underutilized food resources have a much higher nutrient content than globally known species or varieties commonly produced and consumed. With climate uncertainty, there is an urgent need to diversity our food base to a wider range of food crops species for greater system resilience. Traditional and indigenous food crops are less damaging to the environment and address cultural needs; they also preserve the cultural heritage of local communities. Successful food systems in transition effectively draw on locally available food varieties and traditional food culture. Although many traditional subsistence systems depend on one or more staples such as cassava, sago, rice or maize, such diets are kept diverse and balanced through small but complementary amounts of animal-source foods including birds, fish, insects and molluscs, as well as sauces and condiments obtained from forest plants.

It is imperative to collect and document local knowledge, encompassing all aspects of indigenous and underutilized foods, from traditional beliefs to utilization and agronomic practices. Promoting the use of underutilized species needs to be achieved by highlighting their importance in their current production areas as well as exploiting further opportunities to extend their production and consumption. This information should be useful for both product development and awareness-raising.

Emerging from the meeting "Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific", held from 31 May to 2 June 2012, in Khon Kaen, Thailand, this publication describes the significant contribution of underutilized and indigenous foods to human well-being and health. It also highlights the importance of protecting, using, developing and sustaining local food systems. It provides summaries and presents possible solutions, starting with evidence on the effectiveness and impact of underutilized and indigenous food systems on nutritional improvement.

The product of a two-year collaborative effort among Khon Kaen University, Thailand, the Food and Agriculture Organization of the United Nations and other partners, this publication sheds light on the need to promote underutilized and indigenous food sources for overcoming malnutrition and hunger in the Asia-Pacific region. I sincerely hope that this publication will serve as an important step towards conserving and sustainably utilizing traditional and indigenous food resources.

Hiroyuki Konuma
Assistant Director-General and Regional Representative
for Asia and the Pacific
Food and Agriculture Organization of the United Nations

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Acronyms and abbreviations

AVRDC	The World Vegetable Center
ALVs	The African Leafy Vegetables
AIAT	Assessment Institute for Agricultural Technology
ADB	Asian Development Bank
APO	Regional Office for Asia, the Pacific and Oceania
GDP	Gross Domestic Product
GAP	Good Agriculture Practices
GEF	Global Environment Facility
CCA	Commodity Chain Analysis
CFF	The Crops for the Future
COA	Council of Agriculture
CGIAR	Consultative Group on International Agricultural Research
FAO	Food and Agriculture Organization
FNPP	FAO-Netherlands Partnership Program
IFAD	International Fund for Agricultural Development
IWFPs	Indigenous wild edible plants
IUCN	International Union for the Conservation of Nature
MDGs	Millennium Development Goals
MSSRF	Swaminathan Research Foundation
MoAC	Ministry of Agriculture and Cooperatives
NRTC	National Research Council of Thailand
NUS	Underutilized and neglected species
NGNESP	Gardening and Nutrition Education Surveillance Project
NWFP	Non-wood forest product
NMC	National Mushroom Center
NGO	Non Governmental Organization
HVCC	Regional High Value Commercial Crops
RAP	Regional Office for Asia and the Pacific, FAO
PNG	Papua New Guinea
PROINPA	Promocion e Investigacion de Productos Andinos
JIRCAS	Japan International Research Center for Agricultural Sciences
UN	United Nations
UNEP	United Nations Environment Programme
UNSCN	United Nations Standing Committee on Nutrition
VDCs	Village Development Committees
WHA	World Health Assembly

Introduction

It is estimated that a total of 925 million people were undernourished in 2010. Around 162 million children under the age of five in developing country are stunted, due to chronic under-nutrition, and 148 million children are underweight. Micronutrient malnutrition is indeed affecting around 2 billion people (over 30 percent of the world population) with serious public health consequences. At the same time, overweight and obesity is becoming a recognized problem, even in low income countries. Around 43 million children under five years of age are overweight, and more than a billion adults, almost equal the number of the chronically hungry and people suffering from undernourishment, worldwide are overweight, of which 300 million are obese.

The double burden of malnutrition – the association of persistent under-nutrition, including micronutrient deficiencies, with increased overweight and obesity – has become a major issue in developing countries, generating unacceptable human and economic costs and undermining development.

Reduced dietary diversity has serious effects on the nutrition and health of rural and urban populations and deprives rural farmers of opportunity to generate income from their produce, whereas dietary diversification is widely accepted as a cost-effective and sustainable way of improving malnutrition. Neglected and underutilized food resources constitute the bedrock of the diversity in traditional and indigenous food systems of developing country communities. Traditional and indigenous foods are less deleterious to the environment and address cultural needs and preserve the cultural heritage of local communities.

Indigenous people living in rural areas possess food resources that are usually not completely understood by agriculture and health sectors. This means that the usual processes of nutrition assessment and identification of food-based strategies for micronutrient promotion cannot take these resources into full consideration for planning. Indigenous peoples are often the most marginalized and disadvantaged regarding health care and other resources for well-being, and extreme poverty is often the result. Thus, most governments designate their indigenous peoples as those most in need of public health attention and food security. For these residents in rural developing areas, the ‘lifestyle and nutrition transition’ experience means decreasing consumption of fish, wildlife, domestic animals and locally grown crops (rich sources of micronutrients) and increased consumption of industrially-processed food. Poor micronutrient intake is a likely consequence, coincident with increasing obesity and other chronic diseases associated with increased caloric consumption in the form of simple carbohydrates and fat.

Successful food systems in transition effectively draw on locally-available food, food variety and traditional food culture. This involves empirical research, public policy, promotion and applied action in support of multisectoral and community-based strategies linking rural producers and urban consumers with traditional and underutilized food systems. A few micronutrient promotion strategies using local food resources have demonstrated success. It is necessary to be aware of special considerations if successful food studies and nutrition-promotion activities are to be carried out with indigenous peoples using their own local food. Tools for the evaluation of traditional food systems of indigenous peoples would be helpful. Techniques for understanding local food availability and use are needed, including scientific data on species, food harvests, storage and preparation practices, acceptability for vulnerable members of the population and potential for increased food availability and consumption are necessary inputs.

There is also a need to identify linkages between biodiversity, food and nutrition through a series of compiled case studies.

Lack of nutritional and agronomic information, a negative attitude towards traditional indigenous foods (termed 'foods for poor'), policies that do not recognize sufficiently the important role of these foods in food security and health, and lack of advocates and champions to promote traditional and indigenous foods are all constraints. Traditional and indigenous food systems once lost are hard to recreate, underlining the imperative for timely documentation, compilation and dissemination of diminishing knowledge of biodiversity and the use of food culture for promoting sustainable diets.

Indigenous foods, neglected and derided by many in the agriculture and food industries as well as by urban consumers, can be an important component in alleviating hunger, malnutrition and protecting the environment.

A century of globalization has reduced the number of plant species used for food and other purposes from roughly 100 000 to about 30. With the global population expected to reach 9 billion by 2050, the Food and Agriculture Organization of the United Nations (FAO) is concerned that the world may not be able to produce enough food to meet demand. Today, an estimated 842 million people suffer from hunger and malnutrition, with over 60 percent of them residing in the Asia-Pacific region.

In view of this, a regional symposium was organized by FAO, Khon Kaen University in Thailand, the National Research Council of Thailand, the Japan International Research Center for Agricultural Sciences (JIRCAS) and Crops for the Future. The goal is a population that habitually consumes diverse diets, mainly consisting of traditional foods and hence higher intake of micronutrients; reduced incidence of nutrition-related chronic diseases and conditions such as diabetes, obesity and cardiovascular diseases; improved farmers' livelihoods; and improved agrobiodiversity at the farm level.

The objectives were 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 at all levels; and to identify policy options and strategic actions for the promotion of underutilized indigenous food resources in the Asia-Pacific region, including evidence based research.

The two-day regional symposium on "Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific", was attended by 150 representatives of governments, UN agencies, the private sector, academic and research institutions, civil society organizations and experts in agriculture, the environment, health and nutrition. A total of 38 countries were represented.

The symposium provided a venue for sharing experiences and information related to underutilized indigenous food sources and looking at ways on how these foods, as a source of good nutrition and balance in diets, can contribute to food security and be considered as a marketable commodity.

Key recommendations

The key recommendations have been proposed as outcome of the Regional symposium. It was proposed to have a regular annual meeting on promotion of underutilized foods with different themes based on increasing challenges and or needs. It was also suggested to include sessions by technical components: small indigenous fisheries, livestock and traditional breeds, plants, forests and mountain ecosystems. It was also agreed that the next meeting will focus on the need to discuss on various aspects related to processing/preservation and marketing.

Policies and strategies

- Promote intellectual property rights through better documentation and validation;
- Disseminate sustainable management plans for underutilized foods;
- Develop a system for documentation of traditional knowledge and practices;
- Promote high-value differentiation through geographical indications (diversity of production, protect farmers against underhand competition);
- Engage policy-makers in promoting indigenous foods. Integrate food biodiversity in government policies and programmes;
- Examine legal instruments to come up with a code of conduct (legal framework) on wild indigenous foods;
- Develop/revise standards for underutilized foods (GAPs, CODEX and etc.);
- Provide harvest rights to the local community; at the same time promote sustainable conservation use: domestication of some wild plants (introducing to farming systems);
- Support/incentives for those who are maintaining plants *in situ* (monetary, ownership, recognition);
- Enhance farmers' incentives to maintain these species on farm;
- Promote processing and post-harvest technology;
- Link with educators and influence curriculum development at schools and universities;
- Integrate issues of underutilized food resources into the educational curriculum;
- Support policies for seed systems for both the public and private sectors;
- Provide legal frameworks to mainstream and provide necessary support;
- Develop joint programmes through MOUs/MOAs among government, private sectors and NGOs to promote underutilized foods;
- Support recognition of indigenous people who depend on production of indigenous foods.

Research

- Validation and screening of indigenous foods (linking science with traditional knowledge);
- Need to identify plants based on their status (e.g. endangered, abundantly available, etc.);
- Research on ecological implications on overharvesting of wild species;
- Propagation techniques/technology for domestication of wild plants;
- Set up databases for different food species (using images, scientific names and their availability in different agro-ecological zones);
- Knowledge of nutritional content of varieties and species;
- Research on allergic agents of different indigenous foods.

Advocacy

- Use Internet knowledge repositories;
- Link to the media (and provide stories);
- Marketing strategies for underutilized foods and consumer awareness of the value of underutilized wild foods;
- Public awareness on the value of underutilized foods and information sharing;
- Promoting food festivals, diversity fairs, food competitions, food tasting using indigenous foods;
- Multisectoral policy advocacy;
- Suggest an International Year of Underutilized Food Resources for further promotion of these foods.

Partnerships and networks

- Enhance a Regional Network of partners to share knowledge, information and research findings using existing networks.
- Promote public and private partnership for promoting underutilized foods.
- Support better networking and linkages using Internet and web-based tools (ICT) and an online platform for exchange of information (e.g. CFF portal).
- Encourage exchange visits, North-South and South-South collaboration among countries for research and collaboration.
- Promote conservation and collection of genetic resources and promote germplasm exchange.
- Exchange of scientists, technicians, researchers and others between academe/universities.

Regional symposium on
'Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific'

Opening session

The symposium was opened in the presence of Prof. Dr Suthipun Jitpimolmard, Vice-President for Research Affairs of the University of Khon Kaen, Mr Sakchai Sriboonsue, Director-General, The National Bureau of Agricultural Commodity and Food Standards, Ministry for Agriculture and Cooperatives, Thailand, Mr Konchit Budagosa, Advisor for the National Research Council of Thailand and Mr Hiroyuki Konuma, Assistant Director-General and Regional Representative, at FAO's Regional Office for Asia and the Pacific.

The opening session highlighted the importance of improving information on utilizing indigenous food resources, including more effective marketing, especially for rural poor and indigenous communities, who can greatly benefit in terms of improved health, nutrition, well-being and poverty reduction. Indigenous people living in rural areas often possess and consume food resources that are not completely understood by mainstream agriculture and health sectors. Many of these foods are highly nutritious and offer tremendous opportunities to enhance food security and nutrition – and rural livelihoods. There is evidence that indigenous communities recognize the health and nutritional benefits of some of the edible plant genetic crops that are part of their traditional food systems. They are well aware of cultivars' specific differences in agronomic and dietary attributes and they often describe certain cultivars or indigenous varieties as having particular nutritional or therapeutic values. This knowledge must be captured and documented and made accessible to those who are developing food security and nutrition interventions and policies.

It was also emphasized that the focus of research and crop improvement on a few widely consumed crops has helped to meet the food needs of the rapidly growing world population, but it has narrowed dramatically the number of species upon which global food security and agricultural incomes depend. Among neglected traditional foods in Asia that could help to meet the needs of local populations are forest fruits, sago palm, medicinal wild plants and edible insects. Denigrated by some as 'foods of the poor' or 'forgotten foods', indigenous and traditional foods can play an important role in stemming the tide of hunger, malnutrition and dangerous decline in biodiversity. Indigenous peoples are often poor, existing on the margins of society and food insecure. Conversely, people living in developing rural areas are often in a dietary transition to modern processed foods that lead to chronic diseases associated with high intakes of carbohydrates and fats. Incorporating more local forgotten foods can be a factor in balancing diets and has the added advantage of leaving a smaller carbon footprint than many modern agricultural methods.

Plenary Session

Selected speakers from different organizations were invited to make key note presentations. The speakers acknowledged that the dietary diversity option is largely ignored. Medical interventions are currently largely focused on promoting supplements and fortified foods rather than promoting locally-available traditional and indigenous food sources.

Dr Kraisit Tontisirin highlighted that many traditional food systems have healthy elements based on local species of high nutritional value and can contribute to mitigating malnutrition. Existing knowledge points to greater action in the use of biodiversity available in local food systems for food security and nutrition programmes, as major steps towards achieving the Millennium Development Goals (MDGs).[1.] There is a crucial link between the maintenance of food crop diversity, indigenous foods and strategies that ensure optimum nutritional status. Unfortunately, food production strategies to date have resulted in increasing dependence on cereals and other starchy staples, especially in poor communities.[2.] This has been linked to poorer nutrition. In this regard, the narrowing of the food base, a global phenomenon, is seen as an important factor affecting dietary diversity. Due to the shift in diet culture towards more processed foods, a loss of traditional elements has occurred. Therefore enhancing the knowledge base on traditional foods, knowledge of the foods that are part of the traditional food systems, is imperative. Of the perhaps 100 000 edible plant species, just three (maize, wheat and rice) supply the bulk of humans' protein and energy needs, with 95 percent of the world's food energy needs being supplied by just 30 plant species. This is contributing drastically to reduced use and eventual loss. There is a dearth of nutritional information on indigenous and traditional foods, and therefore they are largely ignored by international agencies in global food and nutrition initiatives. It was underscored that as part of the solution there is a need to broaden diversity in food and promote consumption of neglected underutilized species, which are locally adapted and more nutritious. Currently these foods are perceived as backward and abandoned by research and policy groups. Crop diversification and promoting the production of the indigenous food base is critical not only for meeting the nutritional needs of the population, but also to ensure the sustainability of soil health and productivity.[3]

The World Vegetable Center (AVRDC) described the share of vegetable consumption; it was noted that there was very low consumption at 171 g/day in South Asia and 144 g/day in Southeast Asia. Indigenous nutrient-dense vegetables can be used to overcome malnutrition cheaply and permanently. Moreover there are huge varieties and diversity of different vegetables in the region. Over 5 000 varieties of indigenous vegetables are maintained at AVRDC. Two highly nutritious vegetables are *Clitoria ternate*, which has multipurpose use and *Hibiscus sabdariffa* which is a very good source of vitamin C. The incredible moringa tree is regrettably underutilized. Its flowers are used for cosmetic medicine, leaves and pods for nutrition, stems for fuelwood and pulp paper, seeds for purifying water and roots for condiments. The nutrient composition of four Moringa species is remarkable and their nutritional benefits are very high. These trees have considerable potential through high density planting and pruning methods, which enable convenient and continuous harvests of young shoots. Other examples are slippery cabbage in the Solomons and leafy greens in Papua New Guinea (PNG).

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[1] http://www.cbd.int/decision/cop/ Convention on Biological Diversity, 2011.

[2] Tontisirin, K. & Bhattacharjee, L. 2010. Agriculture, food and health. *In* Laurette Dubé *et al.,* eds. *Obesity prevention: the role of brain and society on individual behaviour.* Canada, McGill University, California, USA, Life Sciences, Elsevier.

[3] Welch, R.M. & Graham, R.D. 1999. A new paradigm for world agriculture: meeting human needs – productive, sustainable, nutritious. *Food Crops Research*, 60, 1-10.

Underinvestment in research means that these highly nutritious plants lack competitiveness; improved seed availability is also an issue for promoting them. Policy support for research is vital for greater awareness and better promotion. There is also a need for greater promotion of healthy eating, improved nutritional literacy and better access to fruit and vegetables. Increased availability of fruit and vegetables in rural and urban markets is warranted to encourage farmers, the private sector and consumers to produce, distribute and consume more diverse food. Policy support for seed systems is required now for both the public and private sectors. Promotion activities could also be linked with school health, school feeding and sanitation programmes, home gardens and the selection of recipes using indigenous vegetables. It is also important to increase knowledge on nutritional benefits and cooking methods.

Bioversity International presented case studies on successfully promoting traditional food systems. Minor millets in India number ginger millet, little millet, foxtail millet, barnyard millet, proso millet and kodo. These are reliable crops and thrive under difficult conditions; they are very high in nutrition and have a low glycemic index. These millets are being promoted through new product development schemes, including better education, public awareness and marketing activities. They are viable options and more attractive food for households as drudgery in collection is essentially eliminated.

Research shows that there are hundreds of species of African indigenous leafy vegetables that are nutritious. Rural outreach programmes that include new seed systems and agronomic techniques and market links with value chain development activities have increased the availability of indigenous vegetables at supermarkets.

Tropical fruits such as mangifera, garcinia, nephelium, citrus, which are grown in Malaysia, India, Indonesia and Thailand have been promoted through good practices for the management and conservation of tropical fruit tree genetic resources; propagation, value addition of local food culture, marketing local food culture and product diversification, as well as enhancing farmers' incentives to maintain these species on farm are all employed.

The Biodiversity Nutrition Strategy for 2012-2021, developed by Bioversity International, was introduced. The strategy addresses the development of strong methodological and empirical evidence on how agricultural biodiversity contributes not only to livelihood and ecosystem benefits but more importantly to dietary diversity and nutrition; also to ensure that the production of more nutritious foods, through commercial pathways, reflects agricultural biodiversity practices and cultural and consumer preferences. It will also determine best practices and delivery systems for agricultural biodiversity in nutrition and health development programmes and mainstream the role of agricultural biodiversity into public health and nutrition policy and practice by sharing evidence and providing local solutions. The strategy focuses in particular on the role of local and traditional foods as well as neglected and underutilized species. Collaborative research and policy partnerships comprising various stakeholders in UN systems, the Consultative Group on International Agricultural Research (CGIAR), academic and research institutions, value chain actors, development agencies, governments and NGOs, for operationalization was considered.

A presentation was also made on sustainable diets, i.e. those diets with low environmental impacts that contribute to food and nutrition security and to healthy lives for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy, while optimizing natural and human resources. A myriad of local banana varieties were presented and the differences in their nutrient values. It was noted that a local variety contains much higher levels of carotenes compared to highly commercialized bananas. In addition, sweet potato varieties with higher nutritional values were presented. In Thailand 16 185 varieties of rice were cultivated in the past, while nowadays only around 37 varieties are used, out of which only two varieties are under cultivation on 50 percent of the area. Research shows that the varieties which are cultivated now have lower nutrient content. The greater loss of diversity was highlighted.

Crops for the Future (CFF), a global partnership organization to foster enhanced collaboration amongst research and development stakeholders of underutilized crops presented its initiative. The goal is to facilitate access to knowledge on underutilized and neglected species through web portals, monographs, synthesis papers and databases, especially in the areas of production, sustained market access, nutritional security and health. Also to provide information services to various stakeholders (grant and training opportunities, library resources, Internet opportunities), and engage in policy to promote the use of underutilized and neglected species (market access barriers). This partnership aims to increase awareness on the potential and contributions of neglected and underutilized species for livelihoods (conferences, review papers, popular press) and strengthen capacity amongst researchers. A presentation also discussed value differentiation through geographical indications to encourage diversity of production, allow producers to market differentiated and clearly identified products, promote quality and added value production, as well as protection of farmers against underhand competition. In order to further promote underutilized and neglected species, there is a need for national champions and realizing the importance of generating evidence to support the promotion of these species. It was suggested to optimize Internet use for better visibility and knowledge sharing. CFF welcomed participants to join its efforts by becoming a CFF network member.

An interesting presentation was given on the significant benefits of forests. Numerous functions include fodder for livestock, fuelwood and charcoal, stabilizing and sustaining agricultural production, buffering climate change and providing gene pools for food crops. Forest environments offer ample sources of animal (vertebrate and invertebrate) protein and fat, complemented by plant-derived carbohydrates from fruits, tubers and diverse options for obtaining a balance of essential vitamins and minerals from tree leaves, wild plants, mushrooms, nuts and other plant parts. For forest-based societies that draw on traditional knowledge for most of their subsistence needs, the use of these resources contributes to nutrition and health. Although many traditional subsistence systems depend on one or more staples such as cassava, sago, rice or maize, such diets are kept diverse and balanced through small but complementary amounts of animal-source foods including birds, fish, insects and molluscs, as well as sauces and condiments obtained from forest plants. In addition, some spices from forests enhance flavour and taste, and add nutritional and medicinal value to the dishes because of their biologically active phytochemicals. The contribution of forests to food security and nutrition is little known or recognized. Forests are often ignored in land-use decisions and land rights. It is important to ensure sustainability and best practices in utilizing forest foods.

Forest ecosystems contribute to the diets and subsistence of forest dwellers, and in increasingly market-oriented economies they provide a significant portion of the food and medicines consumed by populations. Recognition that the sustainable use of forest resources is essential for local livelihoods and the well-being of national populations provides a foundation for investment in conservation of forest biodiversity and its integration with objectives of climate change, poverty reduction, food security and nutrition, and other development policies.

A paper on producing vegetables through sprouting and aquaponics was presented. It focused on introducing an alternative solution to growing vegetables with reduced energy use, lower water use and landfill, complemented by soil conservation, agrochemical restriction and biodiversity protection. A technology for self-sustaining (low-cost, low-input) food production at home through sprouting and aquaponic systems was presented. There is a need for more research on growing local crops using these technologies, and also innovative new varieties with high phytochemicals and developing new recipes with these new food varieties.

A Parallel session I – wild indigenous plant sources

Indigenous cultivars are in a vulnerable state and are nearing extinction owing to the introduction of high yielding and short duration varieties of crops. Despite low yield and relatively longer duration, the underutilized indigenous cultivars are palatable and are resistant to pests and diseases, as well as being tolerant to drought and natural hazards.

It was agreed by the participants that underutilized minor crop species are still a major source of nutrition for many indigenous communities. Thus, food and nutrition security of poor and marginal rural people is possible through the conservation and promotion of indigenous crop species that contain high nutrition.

Variations in temporal, altitudinal, topographical and other aspects of hills or mountains have created suitable environment for the growth and survival of numerous indigenous food crop species in many countries. Thus, different types of climatic conditions prevail at one point of time. This allows for not only diversified crop species but also different species of insects to continue their activities as pollinators in one or other areas of the country. Cultivation practices, gathering from forests, rivers and streams, food habits and consumption, and migration vary not only by ecological belts, hamlets and ethnicity but also with the impacts of disasters. Hence, people have to be found who have invented and adopted socio-economic, consumption and cultivation practices for coping with such adversities.

Studies on uncultivated indigenous foods would be highly beneficial not only to analyse such situations but also to acquire knowledge on the richness of biodiversity, its importance in diets and measures to be adopted for its conservation and utilization.

The Nepal paper focused on accelerated erosion that is mainly due to increasing encroachment in forest areas and failure to recognize the importance of conservation, management and use of biodiversity. Indigenous crop species are also disappearing fast due to the introduction of modern varieties, particularly hybrids. Farmers have visible benefits of adopting modern varieties over indigenous varieties that have low grain yields, lodging problems, less economic profitability, low yield potential and low response to chemical fertilizers. Hence, due attention is needed for the identification, collection, documentation, evaluation, maintenance, multiplication, preservation and utilization of such wild genetic resources as well as cultivated underutilized indigenous crop species.

A research result in Thailand was presented on the study of wild plants and herbs (especially wild ginger) and their health benefits, most importantly on mitigating human brain damage, improving memory impairment, and improving the cognitive function of middle-aged women.

This session also stressed the fast decline of traditional knowledge because of modern crops that have higher yields; habitat and rapid dietary changes were also noted. Other factors are the growing ignorance among young people about the existence of these nutritionally-rich food plants. This is further exacerbated by lack of major research and extension efforts to improve their husbandry and promote important species. Decline in the use of indigenous foods by rural people could be the reason for increased incidence of nutritional deficiency disorders and diseases.

There is increasing concern that the importation and increased cultivation of improved vegetables may reduce the collection and consumption of edible wild plants and more critically may replace important species. There may be a further decrease in sustainable forest usage, and consequently, disruption of the coexistence of people and forest and loss of traditional knowledge in the near future. The information generated from this meeting will be used as a reference material for research and development, and thus contribute to the sustainable development and conservation of natural resources in many countries.

A study conducted in Bhutan revealed various wild plants that contribute significantly to diets. Many edible wild plants are believed to contain medicinal properties and have positive effects on human health. Some examples are leaves of *Nasturium oflicinalis* used to enhance blood properties; leaves of *Mentha spicata* L. and Gerardiana species that lower blood pressure; leaves of Urtica species that alleviate tuberculosis; flowers of *Adhatoda vasica* Ness, young stems of *Asparagus racemosus*, inflorescence of Cymbidium species and young shoots of *Plectocomia himalayana* Griff also have health benefits. It was noted that many wild species have never been researched properly; some use is based on traditional knowledge and traditional harvesting and cooking methods.

In Mongolia, the traditional nomadic people consume many btypes of wheat, plants, wild vegetables (wild onions), mushrooms, nuts and wild berries from forests such as strawberries, redcurrants, blueberries, cranberries and barberries. However, climate change impacts, deforestation and overharvesting have resulted fluctuating availability of these foods. This has created deficiencies in micronutrients, especially among women and children. Therefore, their sustainable conservation is crucial, especially in the context of climate change.

A paper from the Philippines addressed indigenous plants, especially moringa and bitter gourd (*Momordica charantia* L.), which are eaten and used for medicinal purposes such as treatment of skin diseases, sterility in women, as a parasiticide, antipyretic and as a purgative. Jute mallow (or *saluyot*), amaranth (or kulitis), waterleaf (*Talinum triangulare* [Jacq.] Wild), alugbati, *Basella alba* and *Basella rubra* are widely used in traditional menus and dishes.

Representing the private sector, an owner of a restaurant introduced different culinary aspects for the end user and how to link traditional and indigenous (especially wild plants) foods with restaurants, and catering services that are potential sources for promoting value-added products. The presentation also included the global movement in moving towards indigenous high-end food and the conservation of traditional knowledge and local heritage, including traditional food cultures. Different dishes were introduced to exemplify how to promote various underutilized wild plants in salads. It was emphasized that there is growing interest in the private sector regarding food with minimal chemical content. Local farmers should keep growing native crop varieties, protect their food heritage and pass on traditional and local wisdom on how to eat and cook such produce.

There was a presentation from India on local foods and their usage, such as various cereals and millets, legumes and fermented bamboo shoots. It was reported that most of traditional use of wild foods is based on indigenous belief of health benefits with very few links to research outputs. Much information is available but again it is not backed up by research and therefore not promoted widely. Traditional methods of processing and preservation (such as fermentation) were presented, for example wild plants used for making beer, wines and so forth.

Traditional communities living in remote locations have conserved traditional knowledge but this is disappearing with transitional societies. There is a need for documentation, conservation and promotion of traditional knowledge for biodiversity conservation, otherwise this will be lost and difficult to recover. Questionnaires, interviews, focused group discussions, recipe contests, biodiversity contests, traditional food fairs, among other approaches, are needed for surveys. Some wild edible plants are more nutritious then commonly consumed vegetables. Distinct processing methods and their impact on nutrient retention as well as inactivation of anti-nutritional factors need to be studied.

A Parallel session I-I – wild indigenous animal resources

The importance of recording local knowledge about edible insects in Australia through developing a seasonal availability calendar was highlighted. The challenges are fragmented information, biased by negative attitude towards insects; most observations by anthropologists are not substantiated by entomological knowledge; lack of reference material; and geographical differences in use of insects, crustaceans and molluscs. There is a need to document information on the diversity of edible insects while knowledge is still available. It is also important to document the diversity of species and identify edible insects (invertebrates) using both traditional Aboriginal names and western scientific names. It was also recommended to draw up sustainable harvesting protocols and dialogue on traditional indigenous knowledge and the potential to semi-domesticate some species using Aboriginal and western technology. It is important to document wild food sources for current and future use. There is increasing interest in traditional Australian foods by commercial enterprises (ecotourism and restaurants), Aboriginal traditions, and traditional Aboriginal food sources for health. However adverse environmental impacts must be avoided.

Japan’s case study also focused on the importance of edible insects and traditional knowledge of insects as food sources. Grasshoppers, wasps, long-horned beetles, caterpillars, silkworms, aquatic beetles, aquatic larvae and cicadas are commonly consumed. Processing, marketing and value addition for edible insects was highlighted. Harvesting and consuming insects is associated with subsistence and lifestyles in rural areas combinedas well as regional cultural preferences.

There was a presentation on ‘Informal market and potential contribution of edible tarantulas and crickets in Cambodia to rural livelihoods (preliminary findings from a field survey)’. This research is part of a WINFOOD project implemented in Cambodia that aims to develop nutritionally-enhanced foods for infants and young children in low-income countries, based on improved utilization of traditional foods (semi-domesticated and wild indigenous foods from uncultivated land or aquatic environments), together with improved traditional food technologies (e.g. fermentation).

There is widespread consumption of crickets, spiders, water beetles, bugs and aquatic animals (snails, frogs) in Cambodia in both rural and urban areas. Insect consumption is increasing in rural and urban areas due to an increase in availability. Insects contribute significantly to the income of people in rural areas, especially during the dry season but there is a danger of overharvesting. Cricket trade is increasing, especially through exchange with Thailand and local consumption is increasing. The market is highly informal and awareness among government, national and international organizations is limited. It is essential to investigate the effects of wild harvesting on biodiversity and the bioavailability of micronutrients and proteins from consumption of processed and unprocessed insects.

The promotion of micronutrient-rich small fish for food security and improved nutrition was presented. Small indigenous fish contain more nutrients than large fish. They contain protein and high levels of vitamin A, zinc, calcium, iron, and minerals. Indigenous species such as *mola, darkina, dhela, chanda, kaski* and *punti* can contribute to preventing malnutrition, assist bone formation and prevent anemia. The study also showed that calcium absorption from small fish (*mola*) is higher than milk consumption. Vitamin A content in small fish is much higher than other animal- and plant-source foods. This makes the nutritional value of small fish very valuable and there is a need for sustainable use, conservation and further promotion of these species.

The government and partners are working to establish policies to reduce wetland losses and improve their management. There was a recommendation to breed small fish in ponds and partial harvesting must be practiced. Frequent harvesting with sustainable practice of small amounts of small fish favours home consumption. Harvesting of large fish a few times, for to five months after stocking does not favour home consumption. Further research is needed in particular on nutrient analysis and bioavailability of common small fish species; development of natural and induced breeding techniques of commercially important small indigenous fishes; improvement of transportation techniques of brood and seeds of small indigenous fishes; integration of small fish (rice) culture and development of suitable production techniques.

There is need to measure impacts of the inclusion of small fish in pond ecology, household nutrition and socio-economic conditions of rural people. Gene bank development and cryopreservation of small indigenous fishes and conservation of small indigenous fishes through habitat restoration and sanctuaries is important. The evaluation of the nutritional value of all small indigenous fishes and their variation based on habitats could greatly contribute to the nutrition. Efforts should be directed towards inclusion of more indigenous fish species in aquaculture systems. Post-harvest utilization, product development and shelf-life extension of products and preservation, also need urgent attention. It was emphasized that there is a need to develop a variety of convenient products to replace imported and less healthy foods and snacks, targeting all age groups.

B Parallel session I – adding value to traditional foods

Sustainable production of sago palm and its utilization for strengthening food security was discussed. Its starch capacity in the trunk (300 kg/palm) makes the tree/palm valuable. This palm can be adapted to various severe environments (swamp, peaty soil, acid soil, brackish water). Its production has minimal effects on climate change. It has multiple uses (e.g. food, feed, ethanol). Production cost is low and no agri-chemicals are needed. It is a possible solution to competition between food and energy needs.

Additional presentations focused on the potential use of sago palm as a staple food (carbohydrate extracted from the sago pith can be consumed in this context). Sago palm leaves are used for roofing, its weaved-leaves for mats and the tree offers other significant benefits. Carbohydrate from sago tree can be harvested after at least four years old. Sago palms are typically found in areas unsuited for other forms of agriculture, so sago cultivation is often the most ecologically appropriate form of land use, especially in swampy areas.

In terms of food security, sago flour can be further developed to strengthen Indonesian food security and nutrition. Sago starch contains fibre and carbohydrate. One hundred grams of dry sago typically comprises 94 grams of carbohydrate, 0.2 grams of protein, 0.5 grams of dietary fibre, 10 mg of calcium, 1.2 mg of iron and negligible amounts of fat, carotene, thiamine and ascorbic acid and yields approximately 355 calories.

Sago palm plantation may provide an option to create crop fields from tropical peat swamp forests, resulting in large production of starch for consumption instead of rice. Sago palm plantations may also play an important role in attenuating greenhouse effects.

It is important to promote its sustainable use and species conservation apart from its use as a food source.

All presentations expressed concern about loss of local knowledge, which is important to guide appropriate conservation strategies, form the basis for research and aid the development of acceptable innovations. Documentation of local knowledge urgently needs attention (traditional beliefs and uses, including non-food, recipe development and basic agronomic practices).

B Parallel session I-I – farmed indigenous plants and animals

There was a focues on introducing indigenous wild plants and animals into farming systems. *Pili* trees in the Philippines are attractive symmetrically shaped evergreens with resistance to strong wind.It was noted by many researchers that the *pili* nut is considered superior to the almond. It has a long shelf life. Processed pili kernels are delicious and can be used in the preparation of many food products; they are also the source of edible oil of excellent quality. *Pili* nut pulp and kernels are extremely nutritious, being excellent sources of minerals, vegetable fats and protein. Superior and accredited varieties are available for propagation and distribution; they are high yielding, easy to propagate, bear fruit year round, resistant to pests and diseases, and responsive to low production inputs. The Regional Pili Research and Training Center was established to develop new propagation techniques, evaluate the performance of promising cultivars and to identify, index and collect elite *pili* varieties.

Vitamins and minerals can be returned to contemporary diets through the use of micronutrient-rich underutilized and neglected species (NUS) by transplanting them from their wild habitats into home gardens. This will offset malnutrition and also provide a source of income. The next crucial Crops for the Future research task is compositional analysis of NUS to identify candidate species for breeding trials and domestication. Scientists must standardize methods and techniques for compositional analysis to guarantee consistent, reliable results.

The Thai presentation focused on the farming of two edible insect insects (cricket and palm weevil). Background information on the development of cricket farming methods at Khon Kaen University was outlined and the present state of commercial insect farming was described. After ten years of commercial development the cricket farming industry has developed to supply a range of products to food markets, restaurants and even precooked microwave-ready and packaged products in supermarkets. Farmed insect species face challenges as research has lagged behind the expansion of farm operations. Potential disease outbreak in intensive farming situations is a major risk and requires urgent study. Study of the potential of other insect species as a farmed species is also needed. However, the future for farming insects appears bright as there will always be a demand for affordable protein sources from a growing world population. Insects may be a food for the future.

A paper from Viet Nam detailed the development of a porcupine breeding and farming project in Quang Ninh Province. Porcupine farming was originally promoted in Viet Nam ten years ago by FAO and at the end of the trial project, the local government funded further development. The porcupine farm has now been perfected to the stage that local villages successfully breed and rear the animals for sale as a meat delicacy at local restaurants. The paper clearly showed how a wild animal species can be domesticated and farmed thereby taking pressure off the wild population and increasing income for rural people.

Working group session

The symposium was dedicated to working group discussions on ways forward. The working facilitators were selected and provided with guidance notes to lead the discussions. The working groups each addressed one theme of the symposium, concentrating on issues generated from the presentations and discussions following the presentations. The groups were asked to identify the key challenges, prioritize recommendations, including the role and responsibilities of different stakeholders and provide a report to the plenary sessions.

Working group 1

Title: Indigenous plants from the wild

Facilitator: Dr Micheal Hermann (Global Coordinator, Crops for the Future)
Reporters: Mr Phub Dorji (Bhutan), Mr Pepe Tekii (Cook Islands), Mr Raela Kulasinghe (Sri Lanka)

Problems (gaps/challenges/issues):

- Sustainability of food harvested from the wild (overharvesting);
- Lack of documentation of traditional and indigenous knowledge in particular sustainable management of wild species;
- Can the harvest from the wild be sustained in the face of increasing market demand?
- Lack of scientific evidence on the value of wild plants;
- Lack of and difficulty in certification and traceability of wild foods;
- Ownership and benefit sharing of indigenous knowledge;
- Difficulty in delineating boundaries of traditional species for benefit sharing;
- Lack of management plans for wild food harvesting;
- Inconsistent ingredients and composition depending of agroclimatic conditions;
- Lack of consumer awareness on the value of indigenous food;
- Conflicting interest at different levels of the value chain;
- With commercialization, there is the danger of the indigenous community losing control;
- Lack of knowledge of antinutritional factors in wild plants.

Key recommendations

- Protection of prices for farmers;
- Domestication of potential indigenous plants;
- Need to weigh the potential of commercialization and the fear of overexploitation;
- Validation and screening of indigenous knowledge (linking science with traditional knowledge);
- Documentation of traditional knowledge and practices, encompassing all aspects of underutilized foods in society, from traditional beliefs to agronomic practices, which can be useful for product development and awareness campaigns which should use common information, materials and themes to be effective;
- Introduction of invasive species should be reviewed;
- Agronomic data for wild plants needed (season, agroclimate, microclimate);
- Need to identify plants based on their status (endangered, abundant, availability, etc.)
- Propagation techniques/technology for domestication of wild plants;
- Need for intellectual property rights through better documentation and validation;

- Need for a sustainable harvesting management plan before commercialization of wild foods (parts of harvest, season);
- Give harvesting rights to the local community for sustainable harvests;
- Geographical identification certificates are more applicable to foods collected on communal lands (such as forests);
- Attach premium prices to indigenous and local foods;
- Need to create public awareness on the value of wild foods and their sustainable conservation;
- Engage policy-makers in promoting indigenous foods;
- Public information sharing on wild species;
- Examine legal instruments to come up with a code of conduct (legal framework) on harvestingwild indigenous foods;
- Provide and or create incentives to those who are maintaining the plants *in situ*;
- Provide improved processing technology to remove antinutritional factors;
- Research on the composition of wild plants, based on commonly used wild plants.

Working group 2

Title: Farmed indigenous plant and animal resources

Facilitator: Dr Leocadio Sebastian (Regional Director, Bioversity International)
Reporters: Dr Robert Holmer (AVRDC), Mr Olayiwola Agoro (Nigeria), Ms Scolasticah Odhianbo (Kenya)

Why promote indigenous crops?

- Food and nutrition security;
- Contribute to micronutrient intake and sustainable diets;
- Enhanced climate resilience and adaptation;
- Improved livelihoods;
- Sustainable use of local resources;
- Conservation of biodiversity;
- Export potential.

Ongoing priority interventions

- One-household one-farm programme (Bangladesh);
- Provision of financial incentives to farmers engaged in indigenous crops (Bangladesh);
- Provision of agricultural incentives like training and management of resources (Cambodia);
- Provision of sensitization and education (Seychelles);
- (Some) indigenous vegetables already listed as a high value crops (Philippines);
- Cabinet resolutions supporting indigenous crop and animal species (Thailand);
- Self-Sufficiency Economy Theory (Thailand).

Problems (gaps/challenges/issues):

Knowledge gaps at the stakeholder level

- Indigenous communities;
- Farmers;
- Consumers;
- Private and government sectors;
- Production;
- Post-harvest/processing;

- Marketing.

Knowledge gaps − production

- General low productivity (yield);
- Attempts to increase production often not cost effective;
- Limited research and development support to address these constraints.

Knowledge gaps − postharvest/processing

- Characteristics that makes harvesting/processing difficult and require specific techniques are required;
- Safety and certification concerns; indigenous plants and animals often do not meet existing standards.

Knowledge gaps − marketing

- Low perception;
- Limited supply vs. limited demand;
- Nutritional/antinutritional attributes often unknown.

Other challenges/issues

- Sources of indigenous plants and animals disappearing;
- Local knowledge on indigenous plants and animals is being lost;
- Traditional knowledge transfer from older to younger generations is diminishing;
    - Younger generations' lack of interest in agriculture;
    - Rural-urban migration;
- Limited information on the availability of varieties/animal stocks;
- Intellectual property rights;
- Inclusion of vulnerable groups in promoting indigenous food systems;
- Policy bias towards hybrid varieties.

Key recommendations

- Collection and conservation of indigenous food materials at national and community levels;
- Research and development to enhance yield and quality parameters of indigenous plants and animals; domestication of indigenous plants and animals including; reproduction/multiplication of indigenous plants and animals;
- Participatory approaches should be used in Research and development;
- Socio-cultural research on why particular indigenous food sources are utilized;
- Marketing research for value addition;
- Research on consumer behaviour to develop niche markets;
- Food safety research (to allow certification);
- Development of post-harvest/processing equipment.

<u>What support should be given to the appropriate institutions to promote underutilized food sources?</u>

- Capacity development, enhance knowledge and skills;
- Provide conducive environments for research and development;
- Develop appropriate mentoring and succession programmes;
- Establishment of public-private partnerships where suitable;
- Provide networking and linkage opportunities through Internet-based tools.

Roles of different stakeholders

- Government
  - Provide enabling environmentS through formulation and implementation of appropriate policies as well as support for the various R&D activities;
  - Consider provision of tax reduction and other incentives such as subsidies.
- Researchers
  - Active involvement in the initiation of research objectives together with local communities.

Partnerships and network promotion at various levels

- International
  - Establish working groups and networks;
  - Initiate collaborative research and development activities;
  - Facilitate exchange of genetic material;
  - Enhance South-South collaboration through technology transfer and knowledge exchange, visits/student exchange programmes.

- National
  - Development of joint programmes through involving different sectors;
  - Clear definition of roles and accountability among partners;
  - Documentation and sensitization of indigenous food systems and cultures (exposure trips, special events);
  - Identify champions that will catalyse partnerships and promote indigenous food systems.

Closing session

The last session of the symposium was dedicated to summarizing the feedback from the group discussions on ways forward and the development of an action plan to continue working together.

Challenges in promoting underutilized food resources

Wild indigenous foods

- Overharvesting of foods from the wild;
- Lack of documentation of traditional/indigenous knowledge on management of wild species (identifying/selecting, harvesting, consuming);
- Sustaining wild foods in the face of increasing market demand;
- Lack of scientific evidence on the value of wild plants (nutritional as well as other properties);
- Ownership and benefit sharing of indigenous knowledge;
- Difficulty in delineating boundaries for benefit sharing;
- Lack of management plans for sustainable wild food harvesting;
- Lack of agronomic data on different wild foods;
- Resistance from high levels and lack of political support for promoting underutilized foods;
- Lack of and difficulty in certification and traceability of wild foods;
- Lack of consumer awareness on the value of indigenous food;
- Conflicting interest at different levels of the value chain;
- With commercialization, there is the danger of the indigenous community losing control;
- Protection of prices for farmers, inclusion of women and persons with disabilities;
- Need to weigh between the potential of commercialization and the fear of exploitation of wild food resources.

Farmed underutilized food resources

Production
- Low yield and not cost effective;
- Limited R&D support to the sector;
- Low production;
- Low perception by the people;
- Indigenous varieties are being lost due to climate change and industrialization;

Marketing
- Market size too small for commercial activities;
- Limited resources such as producers;
- Supermarkets are difficult to convince regarding successful commercialization;

Processing
- Need product management techniques;
- Safety and certification concerns; indigenous plants and animals do not meet standards.

Key recommendations

Policies and strategies

- Promote intellectual property rights through better documentation and validation;
- Disseminate sustainable management plans for underutilized foods;
- Develop a system for documentation of traditional knowledge and practices;
- Promote high-value differentiation through geographical indications (diversity of production, protect farmers against underhand competition);
- Engage policy-makers in promoting indigenous foods. Integrate food biodiversity in government policies and programmes;
- Examine legal instruments to come up with a code of conduct (legal framework) on wild indigenous foods;
- Develop/revise standards for underutilized foods (GAPs, CODEX and etc.);
- Provide harvest rights to the local community; at the same time promote sustainable conservation use: domestication of some wild plants (introducing to farming systems);
- Support/incentives for those who are maintaining plants *in situ* (monetary, ownership, recognition);
- Enhance farmers' incentives to maintain these species on farm;
- Promote processing and post-harvest technology;
- Link with educators and influence curriculum development at schools and universities;
- Integrate issues of underutilized food resources into the educational curriculum;
- Support policies for seed systems for both the public and private sectors;
- Provide legal frameworks to mainstream and provide necessary support;
- Develop joint programmes through MOUs/MOAs among government, private sectors and NGOs to promote underutilized foods;
- Support recognition of indigenous people who depend on production of indigenous foods.

Research

- Validation and screening of indigenous foods (linking science with traditional knowledge);
- Need to identify plants based on their status (e.g. endangered, abundantly available, etc.);
- Research on ecological implications on overharvesting of wild species;
- Propagation techniques/technology for domestication of wild plants;
- Set up databases for different food species (using images, scientific names and their availability in different agro-ecological zones);
- Knowledge of nutritional content of varieties and species;
- Research on allergic agents of different indigenous foods.

Advocacy

- Use Internet knowledge repositories;
- Link to the media (and provide stories);
- Marketing strategies for underutilized foods and consumer awareness of the value of underutilized wild foods;
- Public awareness on the value of underutilized foods and information sharing;
- Promoting food festivals, diversity fairs, food competitions, food tasting using indigenous foods;
- Multisectoral policy advocacy;
- Suggest an International Year of Underutilized Food Resources for further promotion of these foods.

Partnerships and networks

- Enhance a Regional Network of partners to share knowledge, information and research findings using existing networks.
- Promote public and private partnership for promoting underutilized foods.
- Support better networking and linkages using Internet and web-based tools (ICT) and an online platform for exchange of information (e.g. CFF portal).
- Encourage exchange visits, North-South and South-South collaboration among countries for research and collaboration.
- Promote conservation and collection of genetic resources and promote germplasm exchange.
- Exchange of scientists, technicians, researchers and others between academe/universities.

It was proposed to have a regular annual meeting on promotion of underutilized foods with different themes based on increasing challenges and or needs. It was also suggested to include sessions by technical components: small indigenous fisheries, livestock and traditional breeds, plants, forests and mountain ecosystems. It was also agreed that the next meeting will focus on the need to discuss on various aspects related to processing/preservation and marketing.

Field trip visit

The last day of the symposium was a field trip to Mahasarakam Province to view a cricket-processing facility. The facility is a depot for the collection of cricket products from local farmers and where post-harvest processing is undertaken prior to distribution to the markets. Delegates were able to see harvested crickets being cleaned, boiled, graded, preserved and packaged. They also had the opportunity to sample crickets as different food products. Between 1.0-1.5 tonnes of crickets are processed daily at the facility.

A family cricket farm was visited and management of the farm was viewed and discussed. Moreover a commercial mushroom farm and processing plant was visited in Khon Kaen Province. This operation cultivates a variety of mushrooms and processes them for sale through various outlets. An on-site restaurant enabled delegates to sample mushrooms in a variety of delicious dishes. In both excursions, the value of producing niche foods for markets was highlighted. In particular, insect farming received much interest by delegates who asked about training, sources and marketing. Mushroom farmers shared information about their crops and recipes for mushroom dishes.

CHAPTER 1

Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific

K. Tontisirin

There is need to promote and support the implementation of initiatives that make the most use of locally available biodiversity based an ecosystem approach to address food and nutrition security issues. The paper outlines five main issues: Understanding what are underutilized and indigenous foods; food supply (consumption) patterns in Asia; health and nutrition benefits of indigenous foods; home gardens for biodiversity and promoting local agricultural production and support to agricultural biodiversity and indigenous foods in the Region.

Keywords: Traditional food systems, food supply consumption, health and nutritional benefit of indigenous foods

Understanding indigenous and underutilized foods

'Underutilized' is commonly applied to refer to species whose potential has not been fully realized. Indigenous food that is often synonymous used signifies food naturally existing or originating in a place or country rather than arriving from another place. The terms "local" or "traditional" food have also been used as synonyms. With regard to the geographical distribution, often a species could be underutilized in some regions but not in others. Understanding the unique local species and varieties of food often requires new identification; food analysis and dietary assessment methods that help define the utilization and application of the food and its systems to the community context in which they are applied. Acquiring nutrient data and intake data for food species and varieties is an integral part of understanding the impact of biodiversity on food security. Less is known about the health benefits or toxicity of the wide range of plants that were traditionally eaten in ancient times. Many of these foods for years are now eliminated from our diet. The small numbers of plants we do eat are being increasingly well studied, and there is knowledge about their vitamin content and antioxidant and health protective effects. The most powerfully protective domesticated vegetables that are largely eaten are spinach, garlic, broccoli, brussels sprouts, carrots, sweet potato, red pepper, winter squash, and frozen peas - more or less in that order. These are outstanding vegetables, and important contributors to nutritional well being. While tubers and roots are an important slow burning energy food, vegetables are responsible for the more subtle feelings of daily well-being and for protection from long term degenerative disease.

In many part of Asia, the emphasis has been on increasing the production of wheat and rice, which has resulted in a substantial increase of the per capita availability of these cereals. Pulses and legumes, which contribute to the nutrient quality of cereal-based diets, have lagged behind. The cowpea (*Vigna unguiculata*) is, for instance, a staple crop for millions of people in sub Sahara Africa, but the same is considered as an underutilized crop in some Mediterranean countries [4] where it was once widely used and now is grown in some restricted areas. Similarly chickpea (*Cicer arietinum*) considered by many Italian scientists an underutilized species in their country is a main pulse crop in Syria and other countries in West Asia. Neglected crops are those grown primarily in their centres of origin or centres of diversity by traditional farmers, where they are still important for the

[4] http:// www.agriculturesnetwork.org/magazines/global/valuing-crop-diversity/underutilized-plant-species-what-are-they

subsistence of local communities. Some species may be globally distributed, but tend to occupy special niches in the local ecology and in production and consumption systems.

Food (supply) consumption patterns in Asia

Food availability data from the FAO [5] show that adverse shifts in dietary composition are taking place at a much more rapid pace than are beneficial changes. Many of them have been driven by dietary globalization that has on the one hand increased dietary diversification, and on the other hand increased consumption of fats and refined carbohydrates. Traditional Asian diets are cereal-based but, with a growing middle class, changes are taking place in the structure and patterns of diets. Relative to traditional carbohydrate-dominated Asian diets, the evolving diets are distinctly higher in fat and protein content [6]. More specifically, these changes have included shifts towards higher energy density diets, characterized by increased consumption of fat and added sugars, saturated fat intake (mostly from animal sources), and reduced intakes of complex carbohydrates, dietary fiber, and fruits and vegetables [7]. Technical advances in agriculture have also led to changes in the source of nutrients, which can have negative implications for health.

Among food grains, there has been a shift from starchy roots and tubers to polished rice and refined wheat. The most undesirable feature of this nutritional transition is the substitution of millets with socially more prestigious and more refined grains. In Asia, notably India for example, the per capita availability of " coarse grains" (millets) has suffered through relative neglect. The resulting distortion in the pattern of food-grain production has in turn been reflected in the relative market prices of these food grains. Since this trend has coincided with the total decline in intake of cereals, the net effect is a 50 percent decrease in the diet's fiber content.

Amidst the changing consumption patterns, examples still abound from the Asia Pacific region on underutilized foods. Work on Indigenous foods from FAO showed that diets of tribal communities in selected regions of India and Thailand provided 59 percent and 85 percent of the dietary energy respectively that was derived from traditional foods supplied from local food production. In contrast, 27 percent of dietary energy was derived from indigenous foods in Pohnpei, in Micronesia [8]. It is noted that an astonishingly narrow range of vegetables is eaten today if we compare the local produce with what scientists and historical observers have recorded as being eaten by tribes in Asian countries and elsewhere. Different indigenous people put different values on some of the plants in their environment, and that is a matter of culture and not a comment on their absolute edibility.

Health and nutritional benefits of indigenous foods from Asia

From a nutrition perspective, fruits like Indian gooseberry or Emblica officinalis (amla) is one of the richest sources of vitamin C and is one of the most frequently used ingredient in tibbi prescriptions. Daucus carota is one of the best repositories of pro-vitamins, alpha/ beta and gamma-carotenes. Although vitamins are being manufactured by synthetic methods, they were originally obtained from plants which till recently constituted their standard source e.g. rice bran for vitamin B1, Arachis hypograe for vitamin B and B2,

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[5] FAO STAT (2006-2008).

[6] Pingali, P. (2007). Westernization of Asian diets and the transformation of food systems: Implications for research and food policy. *Food Policy*, *32* (3), 198 – 281.

[7] Uusitalo, U. P., & Pushka, P. (2003). *Dietary transition in developing countries: Challenges for chronic disease prevention*. Ithaca, NY: Cornell University.

[8] Kuhnlein HV, Erasmus B and Spigelski D (Eds), (2009) Indigenous Peoples' Food Systems, FAO Rome/CINE.

nicotinic acid, vitamin E and pyridoxine, Cicer arietenum Linn. for carotenoids and the vitamins A, D and E. Such substances could be multiplied.

Another indigenous food is Moringa oleifera or drumstick leaves widely grown in India and other South Asian countries [9]. It is a rich source of many micronutrients – beta carotene, folic acid, calcium, iron and vitamin C and it also provides good quality protein. It is often used to mutually supplement and enhance the quality of cereal based diets. It has also been processed as a dehydrated powder and has been used in school feeding and community nutrition programmes. Drumstick leaves grow widely in South Asia and are also used as a live fencing in rural household and community gardens.
Garlic and onion (Allium sativum) which are traditionally used in Asian diets are among the healthiest foods, and onion and garlic bulbs are used as carminatives, aphrodisiacs and expectorants. Garlic juice is employed as rubefacient in skin diseases, earaches, atonic dyspepsia, flatulence and colic. The efficacy of these medicinal plants has found extensive use within treatments for health and disease. Many plants are also protein-rich: Lagerstroemia speciosa Linn (arjuna) has been found to contain (especially in its old leaves and ripe fruit) a hypoglycemic principle having an activity equivalent to 6.77 units of insulin. Soy bean is another indigenous food that has been an important part of traditional foods in Asia: green soybeans, soybean sprout, soybean curd (tofu), tempe, soy milk, miso, natto, soy sauce and soy bean paste. Soy is a good source of protein, high quality oil, micronutrients, fiber and bioactive compounds (isoflavones). Its utilization in Asia needs to be enhanced given its nutritional and therapeutic benefits.

Thailand has a range of indigenous foods and ingredients that characterize its diet and widely popular typical cuisine [10]. Som Tum, an indigenous food from the Esan, Thailand is high in fiber, provides protein, is low in energy, a good source of carotenoids, flavonoids and poly-phenols. It has anti thrombosis and anti antioxidant properties and promotes induction of detoxifying enzymes in cells. Other ingredients indigenous to the Thai diet include Galangal or "Kha" - aromatic, ginger-like rhizome used as flavouring : *0.04 percent volatile oil;* lemongrass or "Ta Khrai" - scented grey green grass used as flavouring: *0.2 - 0.4 volatile oil;* citron/lime or "Ma Nao" – used as garnish for fish/meat dishes: *Hesperidin and Naringin* (proven anti-inflammatory flavonoids). Chilli or "Prik" herb used as a garnish: *capsaicin;* basil or "Maeng Lak" / Ka-Praow" - herbaceous plant: *0.5 to 0.7 percent volatile oil. It is also used in India in certain dishes and religious occasions.* Fish "Pla" common to the Thai and Asians diet is rich in protein, ω-3 and ω-6 fatty acids. Sesame Seed "Nga" is used for oil/flavouring in both Thailand and India. It is also a good source of protein. Sorrel / Roselle "Kra Jeab" – used as flavouring in Thai diets is a good source of *micronutrients, d-malic acid, tartaric acid and hibiscic acid. All these i*ngredients also exhibit *antimicrobial activities* against *Bacillus cereus* and *Staphylococcus aureus*, and *Salmonella typhi.*

Home gardens for indigenous foods and biodiversity

Home gardening that is traditionally practiced in many parts of Asia can serve as important micro-environments for *in situ* or on farm conservation of a wide range of plant genes and additionally provide essential sources of food, fodder, medicines, spices, construction materials and income for rural households. The biodiversity found in home gardens provides households with access to a large variety of nutritious foods thus providing opportunities for better nutrition, food security and income.

[9] http:// www.jatrophabiodiesel.org/moringa/about-plant.php

[10] Tontisirin KT (2010) Paper presented at the *"Food Innovation Asia Conference 2010: Indigenous food R&D to global market",* BITEC, Bangkok.

Experiences with home gardens related projects of Nutrition Division of FAO are good exemplary evidence of the close link between biodiversity and food security [11]. For example, rural home gardens in Lao PDR were seen to increase food production with optimum use of available area, diversify food production, increase food supply and availability and meet nutritional needs of household members. Home garden models for household nutrition garden production have demonstrated the integration of horticulture (variety of vegetables and fruits, including indigenous plants), small livestock and traditional aquaculture production in combination with nutrition education as being key to improving food and nutrition security [12]. As a result of the increased production and access to a larger variety of indigenous vegetable crops, the average production of vegetables reached 245 grams per person/d, compared to the present national per capita daily availability of 64.3 grams per person/d in the rural areas of Central Laos [13].

In Bangladesh, homestead gardens along with small livestock production, and nutrition succeeded in increasing rural women farmers' production and consumption of micronutrient-rich foods, empowering women, and promoting community development. A variety of traditional leafy vegetables indigenous to specific regions in the country were promoted in the homestead gardening programme through interventions supported by non government organizations, Helen Keller International's Gardening and Nutrition Education Surveillance Project (NGNESP), as well as FAO projects in collaboration with the Department of Agriculture Extension in the Ministry of Agriculture [14]. In two decades of operation from mid 90s, homestead food production in Bangladesh improved household food security for five million vulnerable people—nearly four percent of the population—in diverse agro ecological zones across much of the country and showed a substantial decline in Vitamin A deficiency that was attributed to both home gardening and vitamin supplementation strategies [15].

Support to agricultural biodiversity and promotion of indigenous foods

Most countries in the Asian region have attained self-sufficiency in staple cereal crops production. However, the availability of legumes is low, and many countries are importing legumes costing huge amounts in foreign exchange. Dependence on a few legumes in production and market chain, and high demand has lead to increased price for legumes, and thus the poor rural and urban families cannot afford to eat legumes to the desired level (to meet protein needs). Only a handful of legumes are grown on large areas and enter commercial markets. There are many indigenous food legumes whose potential is under exploited and untapped. Many of these indigenous food legumes play a vital role in protein nutrition to poor farm families, especially to women and children, in the region. Looking at the total area cultivated and production, legumes such as soybean, groundnut, chickpea, lentil, common bean, field peas, chickpea, and pigeon pea can be considered as major legume crops. Other legumes that are indigenous and under-exploited are: Adzuki bean, bambara groundnut, black gram, broad bean (faba bean), horse gram, lablab bean, lathyrus, moth bean, rice bean, and winged bean. These legumes which have been cultivated in the region for more than a century have declined in their production and consumption. The potential for expanding the food basket and commercialization of such crops in Asia-Pacific region needs to be strengthened.

[11] CGRFA/WG-PGR-3/05/Inf.9, FAO Activities in Nutrition and Biodiversity, Working Group on Plant Genetic Resources for Food and Agriculture, 3RD Session, October, 2005.

[12] Khammounheuang K, Saleumsy P, Kirjavainen L, Nandi BK, Mahlberg Dyg P, Bhattacharjee L (2004) Sustainable Livelihoods for Human Security in Lao PDR: Home gardens for Food Security, Rural Livelihoods and Nutritional Well Being, Regional Development Dialogue 25 (2):203 -228.

[13] FAO RAP (2006), TCP/LAO/2902 (A) Home gardens key to improved nutritional well being.

[14] Integrated Horticulture and Nutrition Development Project, FAO/DAE, 2007.

[15] Bangladesh National Food Policy Plan of Action, Monitoring Report 2010.

The number of plant species used by humans around the world reportedly is only one third of the number of species which generations of diverse cultures around the world have drawn upon to develop crops that would meet specific needs. Increased reliance on major food crops has been accompanied by a shrinking of the food basket which has been relied upon for generations. The shrinking of the food basket has reduced both the intra and inter specific diversity of crops, increasing the level of vulnerability among users, particularly the poorer sections, for whom diversity in crops is a necessity for survival rather than a choice [16].

Despite the positive developments on the evidence of nutritional benefits of indigenous foods, the overall international legal framework does not adequately provide a secure and predictable basis for research, conservation, and uses of genetic resources for food and agriculture that maximize the potential benefits of indigenous foods for the larger populations. There are a few notable exceptions - e.g., the International Treaty for Plant Genetic Resources for Food and Agriculture (International Treaty) [17] which has the potential to overcome a number of problems -- but there is need to provide clear recommendations concerning the reform of existing laws and the development of international agreements currently under negotiation that would have the effect of better promoting indigenous foods towards addressing food and nutrition security and towards achieving the Millenium Development Goals.

There is also need for focusing on the impact of food regulations on the myriad of traditional/indigenous foods that may have been consumed for years in Asia but which have not been exported to other places, particularly in developed countries that can provide potential markets[18]. Many of these traditional indigenous foods are generally regarded as safe in the countries where they have been consumed for a long time, yet little if any formal scientific information is available on their composition and safety. This is an area of attention and should be researched in the near future.

Conclusion

The emerging health benefits and documentation of indigenous foods in Asia as described above point to the need for strategic community based interventions that would help to improve food security, nutrition and health of populations. There is need to demonstrate and quantify the benefits of the diversity of the indigenous and underutilized foods for livelihoods and to ensure that such information gathered is put to use widely to increase their well being. The more effective use of such diversity can also serve to be a more sustainable and environmentally friendly solution to the problems of food production. Taking cognizance of these unique strengths of indigenous foods there is need to incorporate agricultural biodiversity in the implementation of existing policy tools, such as food-based dietary guidelines of Asia as well as global nutrition strategies and interventions to improve diets and health on a sustainable basis.

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[17] http://www.fao.org/Ag/cgrfa/itpgr.htm

[18] FAO(2010) International Scientific Symposium, Biodiversity and sustainable diets, FAO, Rome.

Promoting traditional food systems for better nutrition and the Bioversity International nutrition strategy

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The link between the presence of rich agrobiodiversity in a particular place and the nutritional status of the people living nearby has not been easy to correlate. Yet there is no doubt that rich agrobiodiversity has the potential to contribute to diet diversification and provide a source of nutrient-rich food. Hence, how to develop effective strategies for optimizing use of local indigenous food systems that employ agrobiodiversity in addressing poverty as well as hidden hunger and malnutrition issues remains a challenge. The paper reviews the work of four Bioversity International projects that aim to enhance the food systems of certain underutilized crops. Bioversity International improved the use of minor millets among very poor farmers in India through reduction of drudgery, more work opportunities, increased income and greater food availability. The African Leafy Vegetables (ALVs) project in Africa involved interventions in the value chain that eventually led to notable and positive changes in cultivation, consumption, marketing and nutritional awareness of ALVs as well as increased biodiversity. Awareness of the nutritious attributes of Andean grains was further given a boost through work with some local partners in South America which led to greater consumption at the family level. The strategy of empowering rural women's groups through value addition of home garden local species and varieties was adopted in a tropical fruit project in Southeast Asia funded by UNEP/GEF. Learning from these projects and recognizing the challenges of linking nutrition with biodiversity, Bioversity International has developed and adopted a nutrition strategy that aims at promoting the use of agricultural biodiversity within food production systems and providing nutritionally-rich food sources through strong evidence-based research and development approaches. This strategy and the above-mentioned cases are discussed.

Keywords: Traditional food systems, agrobiodiversity, nutrition, Bioversity nutrition strategy, biodiversity, ALV project

Status of food diversity

Despite the presence of rich agrobiodiversity and the laudable success of reducing poverty in the Asia-Pacific region, the prevalence of under- and overnutrition is cause for concern (World Bank/IMF 2012; IFPRI 2011). Asia is home to the largest poor and undernourished population that is vulnerable to food insecurity, climate change and economic downturns (Asia and the Pacific Regional Food Security Partnership Framework 2010). In 2010 alone, a staggering figure of 578 million undernourished people was reported in the Asia-Pacific region, representing 62 percent of the global total (although the proportion of people in the region who are undernourished declined from 20 percent of the population

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from 1990 to 1992 to 15 percent from 2006 to 2008). Ninety-one percent of the undernourished people in Asia live in just six countries (India, China, Pakistan, Bangladesh, Indonesia and the Philippines) (FAO Hunger Portal 2012; Konuma 2012). These six countries account for about 85 percent of the total population in this region. Rates of stunting in children less than five years of age, a measure of poverty and undernutrition, are also very high and are only declining slowly, despite improvements (UNSCN 2010).

Eradicating hunger has become more and more complex and challenging in this region because of increasing and volatile food prices, the impacts of climate change and frequent natural disasters, trade policies of food-exporting countries, soaring crude oil prices, increased use of staple foods for bioenergy and other factors (Konuma 2012; World Bank/IMF 2012).

Furthermore, improving macronutrients such as proteins and fats, and micronutrient content in diets is not currently the focus of most national food security programmes. They usually address issues ranging from meeting food energy needs to agricultural intensification of staple food production. In addition to producing sufficient energy or calories, food security programmes should provide an adequate diversity of nutrients necessary for a healthy and productive life. A human diet consistently requires at least 51 nutrients, including water, in adequate amounts (Graham *et al.* 2007). The most vulnerable groups are women and young children, especially in the poorest countries. These groups lack the essential proteins, fats and micronutrients needed to meet their dietary and physiological needs (Alnwick 1998).

In addition to undernutrition, the Asia region is experiencing an explosion of overweight and obese people in all age groups. Often referred to as the 'double burden' of over- and undernutrition, this health challenge is the result of many factors including dietary and lifestyle transitions (World Bank/IMF 2012). The contribution of dietary diversity in reducing the double burden, including obesity and nutrition-related chronic diseases, was recognized by the World Health Assembly (WHA) in 2004 through its endorsement of the Global Strategy on Diet, Physical Activity and Health (WHA Resolution 57.17. 2004). This Resolution urged member states to *…adopt, among other things, increased consumption of fruits and vegetables, and legumes, whole grains and nuts, and to take measures to preserve and promote traditional foods and physical activity*.

There are traditional food systems that maximize use of diversity. They could help to alleviate hidden hunger issues and provide nutrients, texture and flavour often missing from monotonous energy-dense diets characteristic of transition diets. Many of these traditional food systems integrate the use of local crops, animal source foods and other components that are now considered underutilized. These include small-scale community-based systems like home gardens and smallholder farms that are still practised by many smallholder farmers in the Asia-Pacific region. The importance of home gardens and aquaculture in improving access to micronutrient-rich foods has been demonstrated in several programmes. An important case study is the home gardening programme implemented by Helen Keller International in four countries characterized by high levels of hidden hunger − Bangladesh, Cambodia, Nepal and the Philippines. The programme integrated community-based home gardening with animal husbandry which led to a substantial increase in dietary diversification, greater consumption of animal source foods and reduced prevalence of childhood anaemia (Talukder 2010).

Notable in these local and traditional food systems is the key role of women. In addition to being heavily involved in producing the food, women manage the knowledge on seed types and uses, food preparation and storage, and crop management. Women also take charge of marketing the produce and decide what their children consume.

The importance of harnessing agrobiodiversity in our food systems and enhancing traditional food systems that use it is amplified by the fact that only 30 crops provide 90 percent of the world's food energy intake, and four − rice, wheat, maize and potatoes − supply 50 percent of the world's food energy needs. This is despite the fact that of the estimated 300 000 plant species worldwide, 10 000 have been used for human food since agriculture started approximately 7 000 years ago (FAO 2010). The Asia-Pacific region is the centre of diversity for many important but underutilized crops such as small millets (finger millet, kodo millet, barnyard millet, foxtail millet and little millet), minor but locally important legumes (black gram, rice bean, lablab bean, horse gram, etc.), cultivated minor and wild tropical fruits, and indigenous vegetables. In addition, the diversity in foods, flavourings and other components generated by aquaculture and other production systems is being studied and promoted (FAO 2010).

Harnessing agrobiodiversity to improve nutrition will require finding ways and means to use diverse edible species in our food systems sustainably. This will also require enhancing the efficiency and effectiveness of traditional food systems towards supplying household food and nutrition requirements, meeting market requirements through better developed value chains and providing additional income and livelihoods. This is not only important in terms of food and nutrition security, it is an important approach to prepare for and respond to climate, financial and other impacts.

Promoting traditional food systems

For agriculture to play a more important role in improving nutrition, greater focus is required on what happens between production and consumption (Hawkes and Ruel 2011). Andersen (2011) described a food system as a process that turns natural and human-made resources and inputs into food (Figure 1). Food systems are dynamic behavioural systems that can and should adapt to changes.

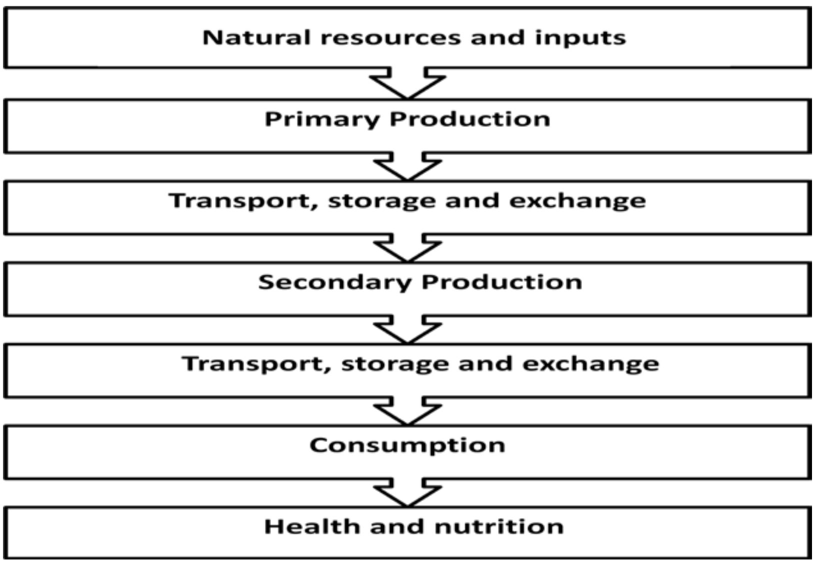

Figure 1. The food system by Andersen (2011) for planning interventions to improve efficiency and effectiveness

In this paper, four cases illustrating Bioversity International's role in enhancing the food systems of certain underutilized crops are discussed. A glimpse of the interventions that have been undertaken on millets in India, leafy vegetables in Africa, Andean grains in

Bolivia and Peru, and tropical fruits in Asia is given. These activities, undertaken by Bioversity International in several locations and with multiple partners, illustrate how local and traditional food systems can be enhanced in terms of increased availability, production and provision of additional income generation and environmental protection (Frison *et al.* 2011).

Millets in India

India has six species of small millets including finger millet (*Eleusine coracana*), little millet (*Panicum sumatrense*), Italian or foxtail millet (*Setaria italic*), barnyard millet (*Echinochloa crusgalli*), proso millet (*Panicum miliaceum*) and kodo millet (*Paspalum scrobiculatum*). These small millets play an important role in the traditional food systems of communities as many kinds of traditional foods and beverages are derived from them. It has also been reported that their grain protein is richer in sulphur-containing and other essential amino acids compared to other major cereals (Bala Ravi *et al.* 2010).

Bioversity's long series of studies to improve the use of minor millets among very poor farmers has shown multiple beneficial impacts in relation to yields, income, profits, the nutritional value of popular snack and breakfast foods, and female empowerment, all promoting the likely conservation of these crops and their biological diversity in farmers' fields.

The results of the project highlighted the importance of looking at the entire value chain of millets from production to value addition, marketing and consumption in enhancing the economic advantage of the farm family (Bhag Mal *et al.* 2010). Accomplishments have been reduction of drudgery, increased employment, strengthened food security and added income. The design and introduction of efficient processing equipment helped in making these underutilized millets commercially more profitable for the farmers and increased possibilities of producing other products made with millets such as bread, noodles, wafers, rolls, cookies and cakes. Development of farm household capacities on the different aspects of millet production, processing, utilization, marketing and related subjects was another important activity. Public awareness activities were conducted on the nutritional value of these crops among farmers and the general public, targeting all sectors, particularly policy-makers. This end-to-end approach proved to be very effective in reinvigorating interest in underutilized and neglected crops. Moreover, the multisectoral participatory approach used in implementing the project that involved working with a range of institutions, farmers and rural community groups helped to ensure its success (Bhag Mal *et al.* 2010).

Leafy vegetables in Africa

In 1996, Bioversity International in partnership with the Rural Outreach Program, World Vegetable Center and other institutions in sub-Saharan Africa implemented a project to enhance the role of African leafy vegetables (ALVs) in improving nutrition and livelihoods (Oniang'o *et al.* 2006). The project was implemented in two phases (1996 and 2001) and involved promotion (information dissemination, capacity development), increased production (seed system, crop management, harvest), improved processing (postharvest handling, quality), improvement of landrace (evaluation, selection and breeding), genetic resource conservation (traditional knowledge − documentation, collection, characterization) and market linkages for leafy vegetables in Botswana, Cameroon, Kenya, Senegal and Zimbabwe.

An impact assessment conducted by Gotor and Irungu (2010) showed that production, consumption and marketing of ALVs had increased since 1997; women still dominated most ALV activities; and households that marketed ALVs were relatively well off compared to those that did not. More than 40 different species were consumed, particularly amaranth, African nightshade, cowpeas, pumpkins, spider plant, bitter lettuce and vine spinach. The study indicated that between 1997 and 2007 there were notable positive changes in cultivation, consumption, marketing and nutritional awareness of ALVs. There was an increase in consumption of ALVs (relative to the 1997 level) of about 45.2 percent of the households while 44.3 percent maintained consumption at the 1997 level. The main reason for increased consumption was attributed to increased awareness of ALV nutritive value. Related to this, the poorest section of the community lagged behind in growing and marketing ALVs, possibly due to low resource endowment (land, labour and other inputs) and limited access to information on ALVS. Lastly, it was also noted that there was increase rather than a decrease in ALV biodiversity through more awareness of the nutritive value of ALVs (Gotor and Irungu 2010).

Andean grain (quinoa, cañihua and amaranth)

Bioversity implemented two phases of the International Fund for Agricultural Development (IFAD)-funded Neglected and Underutilized Species project focusing on three Andean grains (quinoa, cañihua and amaranth) in 34 sites in Bolivia and Peru (Jager *et a l.* 2009). The project involved stakeholders with expertise in grain production, nutritional analysis, conservation, marketing, ecotourism, food quality standards and policy (Jager *et al*. 2009).

Quinoa (*Chenopodium q uinoa*), cañihua (*C. pa llidicaule*) and amaranth (*Amaranthus caudatus*) are used widely among local people in the Andes. They have high quality proteins and a rich micronutrient profile, hardiness and good adaptability to environmental stresses, versatility in use, and rich associated food culture and traditions. Recently, however, the poor economic competitiveness (lack of suitable varieties, low yielding and/or pest and disease susceptible varieties) of these crops with the main commercial cereal crops has changed their role as the staple food of local people.

Utilizing local materials and breeding lines, the project conducted more than 42 evaluation trials between 2001 and 2008 in Bolivia and Peru. From these evaluation trials, six improved varieties were selected and distributed to communities across Bolivia and Peru. A special saponin-free quinoa variety was also developed in Peru and made available to farmers (quinoa grains are naturally coated with bitter saponins). Furthermore, 40 additional varieties obtained from gene banks were successfully reintroduced to farmers' fields between 2001 and 2008.

The project developed a strategic alliance with the 'Alexander Coffee' coffee-shop chain, the Promocion e Investigacion de Productos Andinos (PROINPA) Foundation, 'La Paz on Foot' (a Bolivian ecotourism organization), the Italian NGO Unity and Cooperation for Development of Peoples and Bioversity International. It aimed at raising awareness over the benefits of these grains. The campaigns launched by this alliance informed customers about the nutritional benefits, diverse characteristics and possible recipes of the Andean grains through educational cards placed on the tables of the Alexander Coffee shops. Alexander Coffee also developed novel products prepared with Andean grains. Furthermore, the nutritional value of cañihua, quinoa and amaranth was widely promoted through radio, television and newspapers.

The project has also promoted greater consumption at the family level (particularly among children) through novel and more attractive recipes for cookies, cakes, juices and other products thereby extending the value chain. In order to broaden the impact of the project beyond its pilot sites, Bioversity and its partners have developed a strategy for the scaling up of tools and approaches through the involvement of national value chain actors from public and private sectors, research organizations, development projects and farmer associations (Jager *et al.* 2009).

Tropical fruits in Southeast Asia

South, Southeast and East Asia are home to diverse tropical fruits and their wild relatives that are important sources of food and livelihoods. This rich diversity also plays a role in the stability of ecosystems by providing crucial ecosystem services. Like other crop species, many of these fruits are now underutilized in favour of more commercial fruits and varieties.

Conservation of these species on the farm, therefore, must involve promoting their use and strengthening of market systems. Farmers must have economic incentives to maintain these species on farm.

The United Nations Environment Programme/Global Environment Facility (UNEP-GEF) project, coordinated by Bioversity International, on the conservation, management and use of tropical fruit species studied cases where the use of the diversity of these tropical fruits made major contributions to farmers' income and provided farmers with an incentive to maintain a broad range of tropical fruit trees on their farms (Kruijssen 2008; Kruijssen and Mysore 2010). Case studies included:

a) A cooperative run by women in Chanthaburi, Thailand that processed several products derived from a range of tropical fruits including *Garcinia cowa*, a wild relative of mangosteen with multiple uses (fruits, leaves, wood etc). The cooperative encouraged the members to produce and pack a local Thai dish with cowa leaves called *moochamung*, shampoo from the citrus cultivar Bergamot and durian, tamarind and mangosteen paste. The final products were sold in local markets in Bangkok. The cowa leaves-based product is estimated to generate about US$5 000 profit and wage labour of about US$3.00 per day.

b) In India, *Garcinia indicia* or kokum, an underutilized and nutritious fruit species, is an important source of food and income for many families. A case study was carried out at several kokum-growing locations in Karnataka and Maharastra. In Karnataka, the price of kokum was very low because collectors have limited access to markets. The collectors were not organized to market their product. Most collectors processed their seeds manually (which is laborious) because of the limited number of commercial processing facilities. In contrast, Maharashtra growers were more effectively linked to the market through a horticultural society that provides them with a secure outlet for their products.

c) In Indonesia fresh pomelo is sold on a large scale as fresh fruit. A women's group that processes the white spongy skin of the pomelo into sweets was founded in 2000 in response to fruit fly and fruit borer infestation that made fresh pomelo unsuitable for sale. The group produced candies from the white skin of the rejected fruits using a processing method developed by the Indonesian Government. This gave the women's group additional income of about US$150 per year and wage labour of US$1.66 per day.

Based on these case studies, Bioversity International through the UNEP-GEF funded project Conservation and Sustainable Use of Cultivated and Wild Tropical Fruit Diversity: Promoting Sustainable Livelihoods, Food Security and Ecosystem Services has been working with rural communities in Malaysia, India, Indonesia and Thailand that are dependent on neglected and underutilized fruit species (UNEP-GEF 2010). The focus species include *Garcinia, Mangifera* and *Nephelium*. An example of one of the activities being carried out in Indonesia is the empowerment of rural women farmers' groups through value addition of home garden local species and varieties of mango and citrus. The project, through its Indonesian partner Assessment Institute for Agricultural Technology (AIAT) East Java in cooperation with local NGOs, trained the women farmers' groups on different mango processing techniques to negotiate the cheap price of fruits in the harvest season and to enhance processing activities. Improving existing production techniques and developing efficient channels are also underway to expand product markets (Sthapit *et al.* 2011).

Challenges in using traditional food systems to improve nutrition

The Millennium Development Goals (MDGs) emphasize the importance of nutrition and biodiversity in efforts to halve the proportion of people who suffer from hunger and to ensure environmental sustainability. The recognition of the value of biodiversity for improved nutrition is one component of the shifting paradigm in approaches to malnutrition (Toledo and Burlingame 2006). Specifically, agricultural biodiversity can potentially act as: a safety net against hunger; a rich source of nutrients for improved dietary diversity and quality; and a basis for strengthening local food systems and environmental sustainability (Frison *et al.* 2006). There are, however, many challenges in linking greater use of biodiversity with improved nutrition. Other than widening the variety of food species in diets, nutrient content is also affected by climate, geography and geochemistry, agricultural practices such as fertilization and the genetic composition of the food species. The patterns of food production and consumption also vary widely around the world and most often the positive linkages between agriculture, nutrition and health are not realized (Fan *et al.* 2011). Knowledge about production management of specific agrobiodiversity must improve, and food composition and consumption are important dimensions to be considered. It is also essential to understand how the global agricultural system and the benefits derived from agrobiodiversity influence the drivers of global dietary consumption patterns, nutrition and health status (Bioversity 2011).

Bioversity nutrition strategy

As mentioned in the introduction, the WHA through its Resolution 57.17 adopted the Global Strategy on Diet, Physical Activity and Health. The Resolution built on the expert consultation on diet, nutrition and the prevention of chronic disease which reviewed and summarized the ample evidence available for the importance of diet and physical activity for the prevention of chronic disease. The Resolution urged member states to adopt the following recommendations …*for populations and individuals: 1) achieve energy balance and a healthy weight; 2) limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of trans-fatty acids; 3* ***) increase consumption of fruits and vegetables, and legumes, whole grains and nuts;*** *4) limit the intake of free sugars; and 5) limit salt (sodium) consumption from all sources and ensure that all salt is iodized*. The Resolution also urged Member States to define a series of steps in order to realize these recommendations, consistent with national circumstances, including: *a) establish national goals and objectives; b) develop a realistic timetable for their achievement; c) develop national dietary and physical activity guidelines; d) develop measureable process and output indicators that will permit accurate monitoring and evaluation of actions taken; e)* ***take measures to preserve and promote traditional foods and physical activity*** (WHA resolution 57.17. 2004 – emphasis added by authors).

The Bioversity International nutrition strategy aims to develop strong methodological and empirical evidence on how agricultural biodiversity contributes not only livelihood and ecosystem benefits but more importantly to dietary diversity and nutrition (Bioversity International 2011). The major goal of the strategy is to promote the use of agricultural biodiversity within food production systems and provide nutritionally-rich food sources that contribute to dietary diversity and, potentially, better nutrition and health.

The strategy will attempt to answer the following research questions:

- How does on-farm agricultural biodiversity contribute to household consumption and to dietary diversity and quality?
- How can we link agricultural diversity to improved nutrition and health outcomes and benefits and do these links have an impact?
- Can agricultural biodiversity be scaled up for commercial use while maintaining biodiversity and ecosystems and improving human health?
- What does agricultural biodiversity imply for peri-urban and urban markets and what do trends in urban markets imply for the potential success of agricultural biodiversity?
- How can we better use and promote local knowledge of agricultural biodiversity to improve the health of households?
- What new tools and methodologies can be created and validated that measure agricultural biodiversity associated with dietary patterns?

The objectives of the strategy are:

- Strengthen the evidence base for the role of biodiversity in nutrition and health and the means of incorporating agricultural biodiversity, specifically, into food and nutritional systems approaches.
- Ensure the production of more nutritious foods through commercial pathways that reflect agriculturally biodiverse practices and cultural preferences.
- Determine which agricultural biodiversity practices and delivery systems work on the ground in development programmes to improve nutritional security.
- Mainstream the role of agricultural biodiversity into public health and nutrition policy and practice by sharing evidence and providing local solutions.

The nutrition strategy complements related aspects of the CGIAR Consortium Research Programmes of the Consultative Group on International Agricultural Researc (CGIAR) on agriculture for improved nutrition and health**.** It will also support other research programmes in their activities aimed at enhancing the effectiveness of using agrobiodiversity for better diet and nutrition (Bioversity International 2011).

The strategy will be implemented through strengthened research and policy partnerships. These will include farmers' groups, cooperatives and associations; government and non-government development agencies; value chain actors, academic and research institutions; other CGIAR institutions and UN agencies (IFAD, FAO, CBD etc.).

Conlusion

In linking the presence of rich agrobiodiversity in a particular place and the nutritional status of the people living there, how to develop effective strategies that will optimize use of local indigenous food systems that use agrobiodiversity to address poverty and hidden hunger and malnutrition issues remains a challenge.

The development of methodological and empirical evidence on how agricultural biodiversity contributes to dietary diversity and nutrition is very important in addressing the challenge. The availability of knowledge on the nutritional content of varieties of food species will enable their introduction into the information systems of national food and agriculture programmes, and subsequently into regional and international information systems for genetic resources, all carried out in consistency with national laws (Toledo and Burlingame 2006). This knowledge can be incorporated into planning initiatives promoting the use of agrobiodiversity in traditional food systems; for example, pre-breeding work; participatory variety selection and participatory plant breeding programmes; community-based on-farm conservation and management of crops, fruit trees, farm animal breeds and small-scale family poultry production; community-based product diversification projects; and integrated agro-ecological farming systems programmes. These initiatives can in turn be integrated into the sustainable agriculture, agrobiodiversity and genetic resources components of national programmes, strategies and policies on food security or poverty alleviation for more impact.

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Less visible but yet vital for human health: Nutrient-dense indigenous vegetables and their need for urgent promotion in balanced diets[20]

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This paper describes the importance of indigenous vegetables in traditional food systems with a particular focus on Southeast Asia. Many indigenous vegetables are nutrient dense, may require only low external inputs and currently cope well with abiotic and biotic stresses if grown on a small-scale and in mixed cropping systems. To ensure the food and nutritional security of current and future generations it is an imperative to collect and conserve the full diversity of indigenous vegetable species and other important food crops. AVRDC – The World Vegetable Center's genebank holds close to 60 000 accessions of vegetable germplasm out of which 12 000 accessions belong to some 200 species of indigenous vegetables which have recognized potential for incorporation into resilient cropping systems. Despite the known importance of indigenous vegetables in alleviating malnutrition and poverty, many remain underexploited due to a lack of information on their use, health benefits, field performance, input requirements and marketing potential. A lack of cultivars or lines for widespread distribution and uncertainty about how these plants can fit into common production systems further curtail their use. Project activities of AVRDC – The World Vegetable Center and its partners focus on the rescue, improved conservation, and seed increase of promising lines, cultivar trials and participatory evaluation of selected accessions, and capacity building in germplasm management. Limited investment in research and development in vegetables, particularly indigenous ones, is a constraining factor in further harnessing their potential for sustainable development.

Keywords: Plans Species, nutritional value of indigenous vegetables, agricultural biodiversity and indigenous and traditional food systems

Introduction

Worldwide, 1 500 to 2 000 plant species have been used as vegetables; for Southeast Asia, close to 1 000 species with uses as vegetables are known (Siemonsma and Piluek, 1994). Out of the latter, about 120 species are cultivated commercially or used for home consumption. The term 'indigenous vegetables' primarily refers to plants grown in their centers of origin or diversity (Vavilov, 1926), but also encompasses plant species introduced from other geographical areas that have adapted well to the new environment (Lin et al., 2009). In many cases, these plants naturalized and evolved in the new environment. *Cosmos caudatus* (cosmos) and *Limnocharis flava* (sawah lettuce, velvetleaf) are examples of crops introduced from South and Central America to Southeast Asia (Siemonsma and Piluek, 1994) as part of the great transmigration of plants that followed the voyages of Christopher Columbus to the Americas, which had an enormous impact on agriculture and food systems all over the world.

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Some indigenous vegetables are grown throughout Southeast Asia, with multiple uses and significant economic potential such as *Moringa oleifera* (Moringa, horseradish tree) and *Ipomoea aquatica* (kangkong, water spinach) (Ebert, 2011a; Ebert, 2011b). Others are only known to, and used by, a small group of people in a limited geographical area and mainly planted in home gardens or on a small scale (Engle and Faustino, 2007). While modern, globally used cultivars of standard vegetable crops often suffer when exposed to biotic and abiotic stresses, many indigenous vegetable species, being well-adapted to local agroecological conditions, are hardy and able to tolerate harsher and more difficult environments, often due to their short growth cycle (Maurya et al. 2007). Many indigenous vegetables may require fewer production inputs and do not yet have recognized pest and or disease problems as long as they are planted on a small scale and in mixed cropping systems and thus may not require pesticide applications. Therefore, underutilized, indigenous vegetable crops are important for diversification of production systems and may create less environmental pressure than standard crops.

Nutritional value of indigenous vegetables

As well as fruits, vegetables make a major contribution towards more balanced diets worldwide by providing much needed micronutrients and vitamins on one hand and ensuring variety and good taste in many otherwise bland staple dishes on the other. Some vegetables are known and grown globally—such as tomato, cabbage, cucumber, and carrot. There are many different universal cultivars of these crops available, with the produce coming in different colors and shapes, and with different qualities and uses. Unfortunately, plant breeders have to abide by the preferences of the important players along the value chain of the produce and often sacrifice taste and beneficial nutritional content for improved yield, disease and pest resistance, size, uniformity and extended shelf life. In contrast, many indigenous vegetables which are much less in the focus of breeders and traders, often have a much higher micronutrient content than the well known global vegetables such as tomato and cabbage (Table 1). AVRDC has collected more than 150 species of indigenous vegetables from Asia and Africa and evaluated their nutritional value. Many species are high in either one or several micronutrients including vitamins A, C, E, folates, iron, calcium and antioxidants (Yang et al. 2006; Yang et al. 2007; Yang et al. 2008; Yang and Keding 2009). Although often underutilized --- indigenous vegetables have the potential to play a significant role in addressing several of the United Nation’s Millennium Development Goals, such as hunger and malnutrition, child and maternal health, poverty and loss of biodiversity. All such factors affect the quality of life of the resource-poor living in disaster-prone areas of Asia and other parts of the world.

It has been suggested that perhaps the absence of breeding and ‘crop improvement’ might be the reason for the high nutritional value of mostly untouched local fruits and indigenous vegetables and this has inspired a scientific consortium to identify ‘pre-domesticated’ varieties of crops (mainly fruits and vegetables), which might contain significantly higher levels of nutrients than the varieties currently used for food production (Unilever, 2012).

Table 1. Micronutrient content of common and indigenous vegetables

Nutrient content	**Range**	**Tomato**	**Cabbage**	**Moringa**	**Amaranth**	**Slippery cabbage**	**Sweet potato leaf**
ß-carotene (mg)	0.0 - 22	0.40	0.00	15.28	9.23	5.11	6.82
Vit C (mg)	1.1 - 353	19	22	459	113	82	81
Vit E (mg)	0.0 - 71	1.16	0.05	25.25	3.44	4.51	4.69
Iron (mg)	0.2 – 26	0.54	0.30	10.09	5.54	1.40	1.88
Folates (mg)	2.8 – 175	5	ND[1]	93	78	177	39
Antioxidant activity (TE[2])	0.6 - 82,000	323	496	2858	394	560	870

[1] **Not determined**
[2] **TE = trolox equivalent (mM TE/g FM**
Source: AVRDC

Table 2. Percentage of recommended nutrient intake (RNI) for pregnant women during the first trimester, contributed by 100 g fresh weight of each of six indigenous vegetable crops

	% of RNI* contributed by 100 g fresh weight						
	Protein	Vitamin A	Iron	Folate	Zinc	Calcium	Vitamin E
Slippery cabbage	6	106	5	30-177	11	18	58
Moringa leaves	7	146	11	49	5	10	65
Amaranth	9	160	6	31	6	32	17
Jute mallow	10	198	12	21	0	36	36
Nightshade	8	101	13	10	9	21	28
Cowpea leaves	8	193	6	27	3	54	101

* RNI for pregnant women (1st trimester: protein 60 g, vitamin A 800 µg retinol equivalent (RE), iron 30 mg, folate 600 µg, zinc 11 mg, calcium 1,000 mg, vitamin E 7.5 mg alpha-tocopherol equivalents (a-TE); WHO/FAO, 2004)

Source: Hughes and Ebert, 2012.

Constraints to a wider use of nutrient-dense vegetables

Despite the potentially significant role of indigenous vegetables in achieving food and nutritional security, constraints to their production and consumption still leaves them on the margins of agriculture. This lack of competitiveness is largely due to underinvestment in research and development efforts for their improvement (Javier, 1993). The scientific community can contribute substantially to the drive to move indigenous vegetables into the mainstream of important food crops. Scientific gatherings such as the "2nd International

Symposium on Underutilised Plant Species" held under the motto 'Crops for the Future – Beyond Food Security' in mid-2011 in Kuala Lumpur, Malaysia, contribute toward this goal. Mainstreaming agricultural biodiversity and indigenous and traditional food systems are again in the focus in 2012 as evidenced by this Regional Symposium on "Indigenous and traditional food systems of Asia and the Pacific" organized by the Food and Agriculture Organization of the United Nations together with Khon Kaen University, Thailand and the Thailand National Research Council as well as the forthcoming 1st Regional Conference on "Agrobiodiversity Conservation and Sustainable Utilization" which will be held in September 2012 in Langkawi, Kedah, Malaysia.

By preserving and utilizing biodiversity to select and breed superior varieties whilst retaining or improving their nutritional content, by sustaining and promoting the availability of high quality seeds, by enhancing the traditional knowledge of production through improved cultivation practices, by advocating the benefits of consumption, and by improving food preparation methods for increased nutrient bioavailability and intake -- research and development efforts can contribute to more rapid progress towards achieving food and nutritional security worldwide.

Conservation of the genetic diversity of vegetables, in particular indigenous vegetables

Indigenous vegetables are a very diverse group of crops that includes many different species. Their genetic biodiversity is a cornucopia of promising desired characteristics, especially concerning nutrient density, which have yet to be mined. Priorities set by governmental policies often focus on the more well-known, commercially important vegetable species, neglecting the less well-known, indigenous vegetables. If there is no conscious effort to conserve indigenous vegetable biodiversity, and if the predicted shifts of global agroecological conditions due to climate change and variability materialize, the diversity of less well-known but versatile and valuable indigenous vegetables will be eroded and many species may face extinction. According to a recent study conducted by scientists of the Royal Botanic Gardens, Kew, the Natural History Museum, London and the International Union for the Conservation of Nature (IUCN) one fifth of all plant species on earth face extinction (Hill, 2010). Therefore, it is imperative to collect and conserve the diversity of indigenous vegetable species and other important crops to ensure the food and nutritional security of current and future generations.

AVRDC – The World Vegetable Center is devoted to the conservation, maintenance and distribution of vegetable germplasm. The Center's genebank holds close to 60 000 accessions of vegetable germplasm comprising 170 genera and 435 species from 156 countries of origin, including some of the world's largest vegetable collections held by a single institution, such as for *Capsicum*, tomato, and eggplant (Ebert, 2012). The germplasm accessions and materials derived from AVRDC's breeding programs are made available to the world community as international public goods under a Material Transfer Agreement. Diversity in genetic resources conserved at AVRDC – The World Vegetable Center can either be used directly after comparative trials with the best local varieties have been conducted or they can be targeted as building blocks for breeding efforts to develop improved, superior lines of crops with desired characteristics. A relatively high number of germplasm accessions from the Center's genebank are distributed to in-house scientists, as well as scientists in national programs and the private sector, indicating on-going vibrant research and development activities with both public and private sector partners.

In recent years, AVRDC has made major efforts to collect, evaluate, and conserve locally well-adapted landraces of indigenous vegetables in South and Southeast Asia and Africa. Currently, there are about 12 000 accessions of some 200 species of indigenous vegetables conserved in the AVRDC genebank that have potential for the development of more resilient cropping systems which are well-adapted to global warming (de la Peña et al. 2011). The Center's current germplasm acquisition policy is to prioritize genetic resources at risk of erosion or extinction and to fill gaps in the existing collection as identified by AVRDC breeders. To ensure the safety of the collection, accessions of many crops such as water spinach (*Ipomoea aquatica),* hyacinth bean (*Lablab purpureus*)*,* African and Asian eggplant and its wild relatives, and African nightshade are duplicated in the Svalbard Global Seed Vault in Norway and in the National Agrobiodiversity Center of the Republic of Korea.

The Center is working with partners to collect and conserve the genetic diversity of slippery cabbage (*Abelmoschus manihot*), a popular, highly nutritious vegetable that is indigenous to China, the Indian subcontinent, Malaysia, Australia and the Pacific islands, and which is mostly propagated vegetatively in the Pacific region. Collaborating with national partners, the Center also strengthens in situ conservation of jute mallow (*Corchorus olitorius*), bottle gourd (*Lagenaria siceraria)*, ridged gourd (*Luffa acutangula*) and cucumber (*Cucumis sativus*) in the Philippines through community-based conservation and multiplication to ensure availability of good quality seed for home gardens and commercial production.

All data relevant for genebank operation and accession management are recorded, uploaded, and maintained in AVGRIS (AVRDC Vegetable Genetic Resources Information System. http://203.64.245.173/avgris/.) For users of the Center's germplasm, AVGRIS provides direct access to information pertaining to the passport, characterization, and evaluation data of the accessions maintained by the Center.

To date, the Center has distributed about 625 000 seed samples (a total of 296 000 different accessions and breeding lines) to researchers and breeders of national agricultural research and extension systems, non-governmental organizations, individuals, public and private companies, and universities in 200 countries. This immense range of diverse vegetable germplasm has contributed to the release of 466 improved vegetable varieties to farmers around the world.

Enhancing utilization of indigenous vegetables

Seed production and variety release support

When selected varieties of indigenous vegetables meet the needs of both producers and consumers, demand for the crops can increase dramatically. Sufficient quantities of quality seeds of the improved varieties must be available and accessible to allow farmers to capitalize on new market opportunities. As seed of indigenous vegetables is not easily found in seed shops as only few seed companies venture into this niche market, national research and extension services need to step in – at least initially - to facilitate seed production and distribution systems at the national, local or community level if research and promotion of indigenous vegetables is to be effectively linked with the farming communities. The process of seed distribution to seed shops and farmers depends very much on national regulations. In many countries seed distribution to farmers must be preceded by a formal variety release process. Therefore, projects which intend to promote the utilization of indigenous vegetables should include multi-locational variety trials to support and enhance the variety release process. AVRDC is presently conducting such multi-locational trials with indigenous vegetables in several Asian and African countries.

From 2009 to 2011, AVRDC – The World Vegetable Center undertook project activities supported by the Council of Agriculture (COA) of Taiwan, in collaboration with national partners in Indonesia, the Philippines, and Taiwan, to promote the conservation and use of indigenous vegetables in Asia. Project activities focused on the rescue, improved conservation, and seed increase of promising lines, multi-locational variety trials and capacity building in germplasm management.

Previous project activities implemented by the Center from 2003 to 2006 in Indonesia and other countries in Southeast Asia led to the selection of eleven promising crops *viz.* vegetable soybean (*Glycine max*), amaranth (*Amaranthus* spp.), roselle (*Hibiscus sabdariffa*), Malabar spinach (*Basella alba*), hyacinth bean (*Lablab purpureus*), winged bean (*Psophocarpus tetragonolobus*), bitter gourd (*Momordica charantia*), ridged gourd (*Luffa acutangula*), bottle gourd (*Lagenaria siceraria*), wax gourd (*Benincasa hispida*), and snake gourd (*Trichosanthes* spp.) (Ebert, 2011b).

In Indonesia, all crop seeds cultivated and commercialized must undergo a formal variety release process for assurance of high seed quality (Anonymous, 1992). For this reason, multi-locational tests were conducted in 2010 and 2011 in three highland ecosystems of West Java. Based on preliminary evaluations of the above 11 crops, promising lines of vegetable soybean, amaranth, roselle, and Malabar spinach were chosen for the variety release process and subsequent distribution to resource-poor farmers to improve their income and combat malnutrition (Ebert et al. 2012). Evaluations are still on-going and the prospects are that some indigenous vegetable lines of vegetable soybean and amaranth and Malabar spinach can be officially released in the near future.

Community-based seed systems

A community-based seed system for promising indigenous vegetables was initiated in 2009 in the Bicol region at Hanawan, Ocampo, Camarines Sur to enhance the role of indigenous vegetables for improved nutrition and diversified farm income in the Philippines. The project focused on seed conservation and multiplication to ensure the availability of good quality seeds for home gardens and commercial production. Integrated pest management practices were used for the control of disease and insect pests while fruits were harvested at full maturity to assure good seed quality. Several lines of five indigenous vegetables, e.g. jute mallow, cucumber, bottle gourd, eggplant, and ridged gourd have undergone seed increase. Seed samples of these lines were distributed to other agricultural research centers, farmers' organizations, non-governmental organizations and individual farmers. This community-based seed production approach has been well received by the farming community in Hanawan. The continuation and expansion of this concept to the entire Bicol region has been proposed under the Regional High Value Commercial Crops (HVCC) Program of the Department of Agriculture, and additional resources will be secured to ensure that more farmers will benefit from the project. This classification signifies that indigenous vegetables have already been elevated to high value crops in the Philippines (Ebert et al. 2012).

Improved production practices

Knowledge on improved production practices is essential to enhance utilization of indigenous vegetables as many were, or still are, simply harvested from naturally growing wild plants. Therefore, it is crucial to study and understand the agronomic requirements of indigenous vegetables including soil fertility needs, water requirements, and optimum seasonal growing periods. An awareness of biotic constraints is needed to avoid build-up of insect pests or pathogens and to ensure compatibility with other crops in the production system. Adequate pre- and postharvest handling techniques are required to ensure that quality products will reach markets and the end-user. Such techniques will facilitate harvesting, minimize contamination with microorganisms, and help the farmer deliver quality products to the market.

Value-addition is a further key consideration to increase the market share of indigenous vegetables. Some crops with a short shelf life can be processed to add value. Processing may include drying, salting, fermenting, pickling, canning and juice production, such as roselle juice. In addition to expanding the range of products of these vegetables and to avoid market saturation during peak harvest seasons by ensuring long shelf life of the value-added products, processing also can increase farmers' income. In many cases processed products fetch a higher market value than the fresh produce. In Vietnam for example, the price of pickled Chinese mustard (*Brassica juncea*) was almost twice the price of fresh, unprocessed Chinese mustard (Than et al. 2002).

Promoting indigenous vegetables

Although indigenous vegetables are consumed all over Asia and form an integral socio-cultural component of many communities, their further promotion is needed to better inform and educate a wider range of the population on their benefits. Such promotional activities may be done through demonstrations and field days and by working with schools and community health groups.

Schools are an excellent place where government programs on good health practices can be taught and implemented to achieve behavioral changes at home (Bundy et al. 2006). School gardens are a particularly effective way to advocate the production and consumption of indigenous vegetables (Holmer and Keatinge, 2012). Drescher (2002) shows that school garden programs can have multiplier effects by encouraging the establishment of vegetable gardens at the homes of pupils. The "*Gulayan sa Paaralan*" (Vegetable Gardens in Schools) program of the Philippine Department of Agriculture endorses the establishment of vegetable gardens in all 42,076 public primary and secondary schools of the country to be complemented by home and community gardens. (Department of Agriculture, 2011). The Philippine school garden program is complemented a nationwide campaign called '*Oh My Gulay*' (OMG, 2012) where actors and show business personalities advocate higher vegetable consumption in the country, including indigenous vegetables.

Indigenous vegetables also are included in AVRDC's healthy home gardening kits distributed in India and Africa. A model 6 x 6 m^2 home garden plot has been developed for two districts in India with different sets of cropping sequences; the plot can provide an adequate amount of vegetables for a family of four year-round. The home garden model is presently being modified and adapted to other regions (Keatinge et al. 2012, Hughes and Keatinge, 2012). Because they are easy to grow, yield quickly and can tolerate difficult environments, indigenous vegetables have been selected for inclusion in the Center's vegetable seed kits for immediate rehabilitation of vegetable production among households affected by natural disasters. To date the seed kits have been distributed to earthquake, typhoon and tsunami survivors in Haiti, Indonesia, Sri Lanka, Taiwan, Thailand and India (Keatinge et al. 2011).

Better food preparation methods

Food preparation is a critical aspect of ensuring beneficial phytochemicals of micronutrient-rich vegetables can be absorbed by the body. Vegetables usually are cooked for consumption. Cooking changes the concentration and bioavailability of health-promoting compounds in vegetables. Positive and negative effects have been reported as influenced by the type of processing, the type of vegetable used, and its nutritional characteristics. Cooking also changes the physical properties of vegetables, such as texture and color, factors that strongly impact consumer decisions in purchasing certain produce. Miglio et al. (2008) evaluated the effect of three cooking practices (boiling, steaming, and frying) on phytochemical contents and total antioxidant capacities of carrots, zucchini, and broccoli. They found that antioxidant activity was increased in all cooked vegetables compared with raw vegetables, most likely due to softening of the tissues and increased extractability of compounds from which antioxidant compounds are derived. The texture of steamed vegetables was better than boiled vegetables, but boiling caused discoloration. Frying had the lowest impact on softening, but was less efficient in retaining antioxidant compounds. Cooking in water preserved the antioxidant compounds, particularly carotenoids, better than the other two methods in all vegetables tested. These results may vary from one vegetable type to another but demonstrate that more research on food preparation methods is needed, especially for the under-researched indigenous vegetables.

Apart from the retention of phytochemicals and the potential increase in their bioavailability, the way novel products are presented has a major impact on the adoption, production, and consumption of indigenous vegetables. When promoting a new vegetable to farmers and consumers, food preparation methods must be available at the same time, with recipes adapted to local tastes and ingredients; the dishes also must be presented in an attractive way and should be affordable. AVRDC has developed numerous recipes with local partners to meet local tastes and cooking styles while ensuring bioavailability of micronutrients. The Center has published a collection of high-iron, good-tasting mungbean recipes from South Asia combining whole or split dehulled mungbeans with a range of different vegetables, including indigenous vegetables, to enhance bioavailability of iron. More recently, a collection of attractive and nutritious recipes of indigenous vegetables has been compiled (Lin et al. 2009).

Conclusion

Indigenous vegetables have been used for centuries by local communities since they are well adapted to their specific environments and are often part of the socio-cultural fabric. However, many are underutilized because their value is not appreciated, particularly in regions where the plants are not native. Indigenous vegetables have the potential to be introduced elsewhere for greater crop diversification and increased productivity, which would balance year-round nutrition, provide new market opportunities and enhance farm income. Moreover, they could address issues associated with climate change such as enhancing resilience of farming communities and reducing the demand on non-renewable energy sources, thus lessen the ecological footprint of the food supply chain.

A large number of indigenous vegetables have been evaluated by AVRDC. Many show promise of wider environmental suitability, low input requirements, adaptability to specific cropping systems, easy harvesting and postharvest processing, and high nutritional and health values and warrant further development for extended areas of production and consumption. However, the current imbalance in agricultural investment must be redressed to unleash the potential indigenous vegetables hold to alleviate poverty and malnutrition in the developing world.

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Dietary contribution of underutilized minor crops and indigenous plants collected from uncultivated lands and forests in Nepal

Shyam Kishor Shah[1]

Nepal's different climatic and physiographic settings are suitable environments for the growth and survival of diverse indigenous food crop species. Major and underutilized minor crop species are grown all over Nepal and contribute substantially to the Nepalese diet. Harvesting of natural products is high when natural disasters are severe. Biodiversity depletion is accelerating because of deforestation, failure to recognize the importance of conservation, management and proper use of available natural resources and the introduction of modern crop varieties, particularly hybrids. Moreover vulnerability to pests and diseases has increased. Farmers believe that modern varieties are better than indigenous species due to the latter's low grain yields, economic profitability, yield potential and response to chemical fertilizers. There is a need for identification, collection, documentation, evaluation, maintenance, multiplication, preservation and utilization of wild genetic resources as well as cultivated but underutilized indigenous crop species.

Keywords: Underutilized crop species, wild genetic resources, diet, natural disasters, Nepal

Background

Nepal is located between 26°22' to 30°27' north latitude and 80°4' to 88°12' east longitude. Elevations range from 64 to 8 848 metres above mean sea level. Nepal is a land-locked country sandwiched between the two most populous countries of the world, China in the north and India in the east, west and south. The total area of the country is 147 181 square kilometres.

Physiographic features

Based on land-use patterns, Nepal can be divided into six categories: (1) cultivated agricultural lands − 21 percent; (2) uncultivated agricultural lands − 7 percent; (3) forest- and shrubland − 40 percent; (4) grassland and pasture − 12 percent; (5) waterbodies − 3 percent; and (6) others (snowfields, urban areas, roads, etc) − 18 percent. Physiographically Nepal can be divided into three regions (Figure 1).

Mountain regions are areas higher than 2 000 metres and encompass 51 817 square kilometres. Only 9 percent of this area is used for agriculture and the rest belongs to other categories. Hence, only a small proportion of the population dwells in this zone. Agriculture is livestock-based with little cropping. Physiographic and climatic conditions are extreme and food deficits are common.

Hill regions are areas between 330 and 2 000 metres elevation and encompass 61 345 square kilometres. About 42 percent of the land is used for agriculture. The area is characterized by high ridges and steep slopes with numerous streams giving rise to many microclimates. The Hills account for about 50 percent of the population.

The **Terai region** is located at less than 330 metres above sea level and covers 34 019 square kilometres. Around 66 percent of the total land area is under cultivation. It is known as the granary of Nepal because this zone alone produces 60 percent of the total food

[1] Director General Department of Agriculture of Nepal.

production in the country. Hence, about 45 percent of the total population dwells in the Terai. Over 33 percent of the arable land is irrigated.

Soil characteristics

The lands in the Terai are characterized by 20- to 30-centimetre-thick, friable, generally dark brown topsoil over light yellow or brown loamy subsoil. Soils are mostly acidic, well drained, clay loams or silty loam in texture. Sandy soils occur in the lower part of the Siwalik Range (transitional small hills between the Hills and the Terai), which vary in degree of porosity and poor slope stability. Soils of the upper part of this range have developed on either sedimentary or metamorphic rocks. In steep and very steep dissected areas, the soils are usually eroded and stony. Soils of the river valleys have developed on a series of alluvial deposits and lacustrine sediments.

The lands in the Hills have been developed primarily on igneous and metamorphic rocks. The Hill soils are shallow, stony and rocky. The Himalayan region is characterized by glacial soil groups. The nutrient content of these soils is generally poor. The soils of eastern Nepal are acidic in nature.

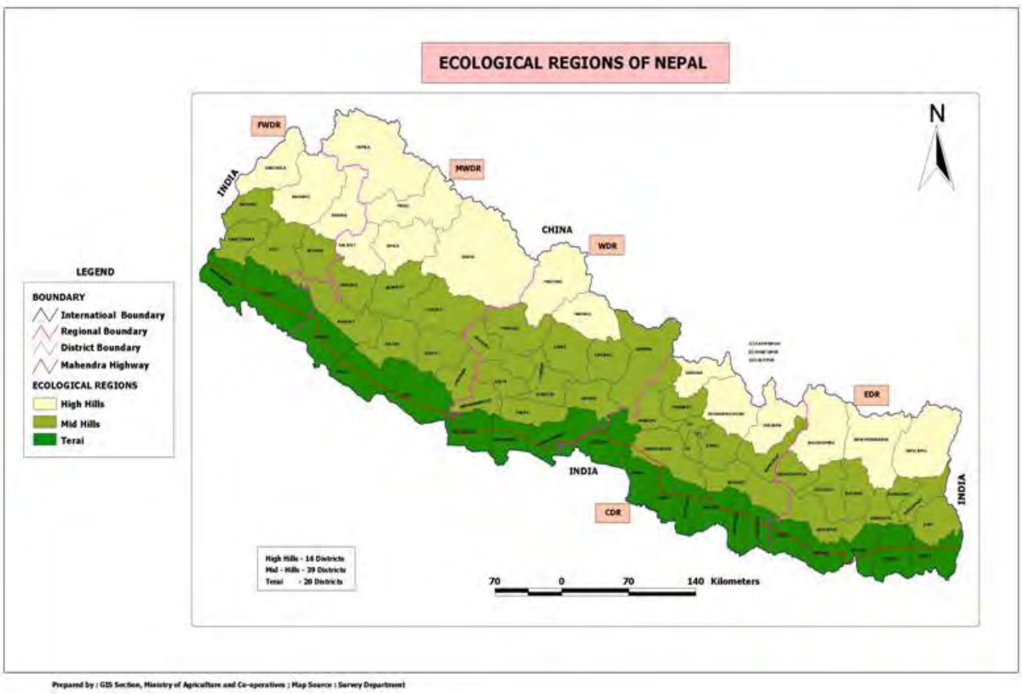

Figure 1. Physiographic regions of Nepal

Climate

The climate in the country varies from subtropical to alpine within a short distance due to tremendous variation in topography, altitude and other aspects of the Hills and mountains. Specifically the altitudinal variation has resulted in the occurrence of all major bioclimatic zones of the world. These factors along with the direction of mountain slopes have created numerous microenvironments ranging from alpine, cool temperate, warm temperate, subtropical and tropical. The snowline lies around 2 500 metres in winter and 4 000 metres in summer. Snow rarely falls below 1 500 metres and remains considerably longer on north- rather than south-facing slopes.

The average annual precipitation in the country is about 1 600 millimetres, approximately 80 percent of which falls between June to September. The southeast monsoon rising from the Bay of Bengal is blocked by the High Himalaya range and passes along it with high rainfall in the foothills of Nepal. The mean annual precipitation varies from more than 6 000 millimetres along the southern slopes of the Annapurna Himalayan range to the central part of the country to less than 250 millimetres in the northern central portion near the Tibetan Plateau. Most of the winter rainfall occurs during December to February. The High Himalayas also act as a barrier to the cold fronts sweeping across from Central Asia, protecting Nepal and northern India and giving them warmer winters. The total number of rainy days varies from 24 to 181 days. Annual sunshine hours vary between 922 and 2 820 hours. The recorded maximum temperature during the summer varies from 25 ^{o}C to 46 ^{o}C and the recorded minimum temperature during the winter varies from -26 ^{o}C to near freezing point in the crop-growing areas.

Traditionally, there are six seasons: *Basant* (16 March to 15 May), *Grishma* (16 May to 15 July), *Barsha* (16 July to 15 September), *Sharad* (16 September to 15 November), *Shishir* (16 November to 15 January) and *Hemant* (16 January to 15 March). Winter, spring, summer and autumn seasons are distinguishable. However, from the farming point of view two seasons were recognized in the past but due to technological innovations, particularly the development of short duration crop varieties and modern cultivation practices, three seasons namely summer, winter and spring are identified.

Land-use categories and administrative divisions

The major land-use categories are forest (42 percent), agriculture, including non-cultivated land (29 percent), grassland (12 percent) and other uses (17 percent). Agriculture is the backbone of the Nepalese economy. The physiographic zones vary widely in their proportion of land use for agricultural purposes. In the mountains 9 percent of the area is used for agriculture and the rest belongs to other categories. In the Hills and Terai 42 and 66 percent of the area is used for agricultural purposes respectively. Administratively, Nepal is divided into five development regions, 75 districts, 95 municipalities and 3 734 Village Development Committees (VDCs).

Food production

Agriculture is the backbone of the Nepalese economy, but farming remains subsistent. It employs 66 percent of the labour force and contributes 33 percent to the Gross Domestic Product (GDP). Although agriculture’s share in the GDP has been declining, it is still the largest single sector contributing substantially to the national economy. Hence, this sector has a pivotal role for any attempts to raise income, alleviate widespread poverty and uplift living standards of the Nepalese people. However, agricultural growth has been slow and has barely kept pace with population growth during the last two decades.

About 21 percent (3.2 million hectares) of the total land area of Nepal is used for cultivation and the principal crops are rice (45 percent), maize (20 percent), wheat (18 percent), millet (5 percent) and potatoes (3 percent), followed by sugar cane, jute, cotton, tea, barley, legumes, vegetables and fruits.

Nepal's food balance is quite variable. The country experienced food deficit till 1998/1999 and a positive food balance for the period between 1990/2000 to 2004/2005 (Table 1). Despite the positive food balance in various periods at the national level, 32 districts − mostly mountains, the Hills and a few in the Terai − still observe food deficit. Difficult terrain and a poor road network have severely constrained flow of surplus food grains in the Hills and mountain districts. Food deficit is met through the collection and harvesting of indigenous products from the forest and temporary outmigration from deficit districts to food surplus districts and India.

Table 1. Production, requirement and balance of staple food (edible cereal grain) in Nepal

Year	Production, tonnes	Requirement, tonnes	Balance, tonnes
1990/91	3 618 955	3 486 776	132 179
1991/92	3 373 448	3 561 838	-188 390
1992/93	3 292 126	3 633 724	-341 598
1993/94	3 585 112	3 723 722	-138 610
1994/95	3 397 760	3 882 915	-485 155
1995/96	3 913 878	3 948 229	-34 351
1996/97	3 972 587	4 079 135	-106 548
1997/98	4 027 349	4 178 077	-150 728
1998/99	4 097 612	4 279 491	-181 879
1999/00	4 451 939	4 383 443	68 496
2000/01	4 513 179	4 430 128	83 051
2001/02	4 543 049	4 463 027	80 022
2002/03	4 641 466	4 565 820	75 646
2003/04	4 884 371	4 671 344	213 027
2004/05	4 942 553	4 779 710	162 843
2005/06	4 869 440	4 890 993	-21 553
2006/07	4 815 284	4 995 194	-179 910
2007/08	5 195 211	5 172 844	22 367
2008/09	5 160 406	5 293 316	-132 910
2009/10	4 967 469	5 297 444	-329 972

Note: Staple food or edible cereal grain includes rice, maize, wheat, millet and barley.
Source: Statistical Information on Nepalese Agriculture (2009/2010). Agri-business Promotion and Statistics Division of the Ministry of Agriculture and Cooperatives, Kathmandu, Nepal (2010).

Underutilized indigenous minor food crops of Nepal

Major and underutilized minor crop species are grown all over Nepal. Most of the underutilized minor crops are diverse indigenous species. The list of underutilized crop species is large and some are presented in Annex 1. Such crops contribute substantially to the Nepalese diet.

Available information indicates that among the 60 reported species of amaranth in the world at least 11 species are cultivable grain, green vegetable, wild and weedy varieties. Nepal, being proximal to the original and secondary sources of origin of different cultivated plants, harbours numerous wild relatives of cultivated agricultural crop plants like rice, wheat, barley, buckwheat, citrus and other fruit crops, several vegetable crops, and so forth. It is reported that 83 different wild relatives of 46 genera under 18 families of 36 agricultural crops exist (ABTRACO 2008).

There are several examples of crop variety improvement through the use of plant genetic resources in Nepal. A total of 230 improved varieties of 45 crops have been released representing cereals, legumes, oilseeds, potato, vegetables, industrial and forage crops (MoAC 2010).

Historically, Nepalese farmers have grown several species of food crops including many varieties of millet, barley and buckwheat. Generally, underutilized indigenous food crops are sold mostly in the local markets owing to their small volume of production (Figure 2). However, such indigenous cultivars are in a vulnerable state and near extinction owing to the introduction of high-yielding and short duration varieties of crops. Despite low yield and relatively longer duration, the underutilized indigenous cultivars are palatable, resistant to pests and diseases, and tolerant to drought and natural hazards. They are still major sources of nutrition for many indigenous communities in Nepal. So food and nutritional security of the poor and marginal rural people is possible through the conservation and promotion of indigenous crop species that are highly nutritious (Annex 2).

Figure 2. Varieties of indigenous food items on sale along a footpath in Kailali District in 2011 (courtesy Dr Shiddi Ganesh Shrestha)

Congenial environment for biodiversity

Nepal's climatic and physiographic settings are suitable environments for the growth and survival of numerous indigenous food crop species (Shrestha 2007). As different types of climatic conditions prevail at one point of time, this allows for not only diversified crop species but also the proliferation of different kinds of insects to serve as pollinators in one or other areas of the country. Therefore, Nepal is richly endowed with biodiversity. The cultivated crop species owe their variability to the presence of about 120 wild relatives of the commonly cultivated food plants and their proximity to cultivated areas; there are 60 food species (fruit, vegetables, legumes) and 54 wild relatives of food plants (Upadhyaya and Joshi 2003). Crops such as rice, rice bean, egg plant, buckwheat, soybean, foxtail millet, citrus and mango have high genetic diversity relative to other food crops.

The Nepalese environment is congenial for the survival of people and livestock. People and domesticated animals from high mountain areas can migrate to lowlands when there is a shortage of food or harsh climatic conditions. This has also promoted linkages between high- and lowland socio-economic environments.

Biodiversity for coping with disasters

Nepal has almost all types of microclimates and a wide range of biodiversity. Hence, it is a safe haven for many plant and crop species even in the event of climate change-related disasters. At any given point in time some areas of the country experience heavy rainfall while others are dry. Similarly, some areas are very cold and others are very hot. In the same altitude of a hill or a mountain the temperature and moisture regime can differ (the northern aspect is cooler than the southern aspect). This has resulted in a vast array of biodiversity.

Cultivation practices; harvesting of natural products; food and consumption habits; and migration vary not only by ecological belts and ethnicity but also in the event of natural disaster. People have devised consumption and cultivation coping strategies to address adversity. Most mountain and hill districts are food deficit but they all survive due to the availability of uncultivated indigenous foods in the natural surroundings. However, no studies have been conducted to analyse this situation. Such studies would be highly beneficial not only to analyse such situations but also to learn about the richness of biodiversity, its importance in the Nepalese diet and measures to be adopted for food crop species conservation and utilization.

In case of crop failure people migrate to food-sufficient areas for employment to purchase food. Generally, the migration is seasonal but it becomes permanent in the case of prolonged events and natural disasters such as landslides, floods and drought.

In these contexts the forests and other features of the natural environment have become important safeguards in the event of natural disaster. Harvesting of natural products is high when natural disasters are severe. Generally, people gather non-wood forest products such as wild yam, bamboo shoots, wild colocasia, amaranthus, chenopodum, allum, ipomoea, mentha, mushrooms, wild figs, wild bananas and mulberry from the forest (Shrestha 2008 in ABTRACO 2008). In addition, fish and crabs are caught from watercourses and wild animals and birds are hunted in the forest.

Traditional irrigation systems developed by farming communities have facilitated the growth of indigenous crops even on canal and channel bunds (Shrestha 2004). Blackgram, soybean, pigeon pea and maize are the common bund crops during the monsoon season. Farm households also grow ridge gourd, bottle gourd, snake gourd, bitter gourd, beans and cucumber and other hedge plants planted along the bund. These crops are not only food and cash sources but also add fertility to the soil. Irrigation offers new opportunities for farm households to harvest Ghungi (a kind of snail), a protein-rich food source, from their irrigated fields in the Terai.

Generally, Nepalese farmers prefer to grow several kinds of food items to cope with natural disasters (Shrestha 2004). Hence, food crops are not the only source of nutrition for Nepalese people.

Biodiversity depletion

Biodiversity depletion is accelerating in Nepal because of increasing encroachment in forest areas, failure to recognize the importance of conservation, management and use of natural resources and the introduction of modern varieties, particularly hybrids. Several wild relatives of cultivated plants and other wild genetic resources are also diminishing in this respect. This has resulted in increased vulnerability to pests and diseases. Farmers believe that modern varieties are better than indigenous species due to the latter's low grain yields, economic profitability, yield potential and response to chemical fertilizers. There is a need for identification, collection, documentation, evaluation, maintenance, multiplication, preservation and utilization of wild genetic resources as well as cultivated but underutilized indigenous crop species.

Conclusion

The landraces and wild relatives of fruit plants and crops are the building blocks of new varieties. Selection of promising clones from these wild relatives through systematic evaluation and selection should be done. Harvests of non-wood forest products are major sources of medicine and nutrition for rural communities. However, international support is needed to conserve, manage and utilize these assets for future generations, especially during this era of climate change threat.

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Table **1. Important foods of Nepal**

Local name	English name	Scientific name
Grains:		
Phapar	Buckwheat	*Fagopyrum eculentum*
Jain	Hog millet	*Avendabyzantina* sp.
Jaun	Barley	*Hordeum vulgare*
Uwa	Uwa	*Andorogen sorghum*
Kagano	Foxtail/Italian millet	*Setaria italica*
Bajra	Bajra	*Pennisetum typhoideum*
Junelo	Jowar	*Sorghum vulgare*
Chino	Ragi	*Panicummiiaceum* sp.
Pulses:		
Mash	Blackgram	*Phaseolus mungo*
Gahat	Horse gram	*Dulichos biflorus*
Mung	Green gram	*Phaeolus aurevs*
Rahar	Red gram/pigeon pea	*Cajanus cajan*
Masyang/Gurans	Moth bean	*Phaseolus aconitifolius*
Chana	Bengal gram/chickpea	*Cicer arientinum*
Khesari	Khesari	*Lathyrus ativus*
Matar/Keraun	Garden pea	*Pisum sativum*
Bakulla	Broad bean/horse bean	*Vicia faba*
Bodi	Cowpea	*Vigna sinensis*
Simi	Field bean	*Doclichos lablab*
Rajma	French bean	*Phaeolus vulgaris*
Bhatamas	Soybean	*Glycine max*
Green vegetables:		
Lunde	Amaranth	*Amaranthus spinosus*
Chaulain	Araikeerai	*Amaranthus tristis*
Bethe	Bethe	*Chenopodium album*
Chukandar	Beet green	*Beta vulgaris*
Chana Ko Saag	Bengal gram leaves	*Cicer arientinum*
Lauka Ko Munto	Bottle guard leaves	*Lagenaria vulgaris*
Bakulla Simi Ko Saag	Broad bean leaves	*Brassical oleraceavar*
Ganjar Ko Saag	Carrot leaves	*Brasical oleracea*
Celery Saag	Celery	*Apium gravelen*
Karkalo Ko Saag	Colocacia leaves	*Colocacia antiquoxum*
Hariyo Dhaniya	Coriander leaves	*Coriendrum sativum*
Bodi Ko Saag	Cowpea leaves	*Vigna catiang*
Sajihan Ko Saag	Drumstick leaves	*Moringa oleifera*
Methi Ko Saag	Fenugreek leaves	*Trigonella foenum*
Chamsur Ko Saag	Garden cress	*Lepidium sativum*
Chariamilo	Garden sorrel	*Oxalee corniculata*
Lasun Ko Saag	Garlic leaves	*Alium sativum*
Kheshari Ko Saag	Kheshari eaves	*Lathyrus sativus*
Gyath Govi Ko Saag	Knolkol greens	*Brassicae oleraceae*
Koiralo Ko Saag	Cink bauhinia	*Bauhinia purpurea*
Salad/Miri Ko Saag	Lettuce	*Lactucasativa* sp.
Latte Ko Saag	Love-lies bleeding	*Amaranthus caudatus*
Poi Saag	Poi saag	*Basella rubra*
Padina/Babari	Mint	*Mentha spicata*
Tori Ko Saag	Mustard leaves	*Brassica campestris*
Nundhikki Ko Saag	Kitchen garden purslane	*Portulaca oleraceae*
Patuwa Ko Saag	Patuwa leaves	*Corchorus capsularis*
Aalu Ko Saag	Potao leaves	*Solanum tubersum*
Pharsi Ko Munto	Pumpkin leaves	*Cucurbita maxima*
Mula Ko Saag	Radish leaves	*Raphanus satuvus*
Rayo Ko Saag	Rape leaves	*Brassica napu*
Kusum Ko Saag	Sunflower leaves	*Carthamu tinctorius*
Palaungo Ko Saag	Spinach leaves	*Spinacia oleraceae*
Bhatmas Ko Saag	Soybean greens	*Glycine max*
Sskarkhand Ko Saag	Sweet potao greens	*Ipomoea batatus*

Local name	English name	Scientific name
Iamali Ko Saag	Tamarind greens	*Tamarindus indicus*
Salgam Ko Saag	Turnip green	*Brassica rapa*
Sim Ko Saag	Water cress	*Naturtium officinale*
Golbhenda	Tomato	*Lycopersicon esculentum*
Rukh Tamatar	Tree tomato	*Cyphomandra betacca*
Chyau	Mushroom	
Kubhindo	Ashgourd	*Benicasa hispida*
Lauka	Bottlegourd	*Lagenaria vulgaris*
Tito Karela	Bittergourd	*Momordica charartia*
Bhanta	Brinjal	*Solanum melongena*
Chhyapi	Leek	*Allium porrum*
Bakulla Simi	Broad bean	*Vicia faba*
Cauli	Cauliflower	*Brassica olereceae*
Squish	Cho-cho marrow	*Scchium edule*
Jhuppe Simi	Cluster bean	*Cyamopi tetragonoloba*
Karkalo Ko Danth	Colocacia stem	*Colocasia autiquorum*
Hariyo Bodi	Green cowpea	*Vigna catjan*
Kakro	Cucumber	*Cucumis sativus*
Asare Simi	Double bean	*Faba vulgaris*
Sajihan	Drum stick	*Moringa oleitra*
Hiude Simi	Field bean	*Dolichos lablab*
Simi	French bean	*Phaseolus vulgaris*
Bhende Khursani	Giant chilli	*Capsicum annum*
Kathar	Jackfruit	*Artocarpus heterophyllu*
Gyanth Govi	Knolkhol	*Brassica oleraceae*
Ramtoriya	Lady’s finger	*Abelmoschus esculentus*
Badahar	Lakooch	*Artocaropus lakoocha*
Kamal Ko Danth	Lotus stem	*Nelumbium nelumbo*
Kancho Aanp	Green mango	*Mangifera indica*
Pyaj Ko Danth	Onion stalk	*Allium cepa*
Pyaj	Onion	*Allium cepa*
Kancho Mewa	Green papaya	*Carica papaya*
Parwal	Parwar	*Trichosanthes dioca*
Keraun	Pea	*Pisum sativum*
Rato Simi	Pink bean	*Phaseolus* sp.
Kera Ko Bungo	Banana flower	*Musa sapientum*
Kera Ko Danth	Banana stem	*Musa sapientum*
Kancho Kera	Green banana	*Musa sapientum*
Pharsi	Pumpkin	*Cucurbita moxima*
Pharsi Ko Phool	Pumpkin flower	*Cucurbita moxima*
Pharsi Ko Munta	Pumpkin leave	*Cucurbita moxima*
Rayo Ko Duku	Rape plant stem	*Brassica napus*
Rahar Ko Kosha	Green redgram	*Cajanus cajan*
Ghiraunla	Ridgegourd	*Luffa acutangula*
Sanai Ko Phool	Sunhemp flower	*Cortalaria juncea*
Simal Ko Phool	Silk cotton flower	*Bombax malbarium*
Chichinda	Snakegourd	*Trichoanthes anguina*
Palungo Ko Danth	Spinach stalk	*Spinacia oleraceae*
Tante/Tarware Simi	Sword bean	*Canvalia gladiata*
Tinda	Tinda	*Citrullus vulgaris*
Golbheda	Tomato	*Lycopersicon esculentum*
Kurilo		
Kamal Ko Phool	Water lily	*Wymphaea nouchali*
Singada/Pani Phal	Water chestnut	*Pastalum sorobiculatum*
Koiralo	Mountain ebony	*Bauhinia variegata*
Kavro	Banyan	*Ficus virens*
Neem Ko Saag	Neem leaves (tender)	*Azadirachta indica*
Bans Ko Tama	Bamboo tender shoot	*Bambusa arundinacea*
Hattibad/Kettuke Ko Tama		
Roots and tubers:		
Kera Ko Jara	Banana rhizome	*Musa paradisica*
Chukandar	Beet root	*Beta vulgaris*

Local name	English name	Scientific name
Ganjar	Carrot	*Dacus carota*
Pindalu	Colocacia	*Colaria antiquerum*
Lasun	Garlic	*Allium sativum*
Ghar Tarul	Yam	*Dioscora* sp.
Ban Tarul	Wild yam	*Dioscorea versicolor*
Githa		
Vyakur		
Kamal Ko Jara/Serakhi	Lotus root	*Nelumbium nelumbo*
Haledo	Mango ginger	*Cacuma amada*
Pyaj	Onion	*Allium cepa*
Aalu	Potato	*Solanum tuberosum*
Mula	Radish	*Raphanus sativus*
Sakarkhanda	Sweet potato	*Ipomoea batatus*
Salgam	Turnip	*Brassica rapa*
Ole	Elephant yam	*Amorphopharlus campanulatus*
Nuts and oilseeds:		
Simta	Chilgoza	*Pinus gerardiana*
Katuns	Chestnut	*Castranopsis hystrix*
Okhar	Walnut	*Jaglans regia*
Til	Gingelly seed	*Sesamum indicum*
Kalo Til	Niger seed	*Guizotia abyssinica*
Badam	Groundnut	*Arachis hypogaea*
Aalas	Linseed	*Linum usitetissimum*
Tori	Mustard seed	*Brassica nigra*
Suryamukhi Phool	Sunflower seed	*Helianthus annuas*
Kusum Phool	Safflower	*Carthamus tinctorius*
Nariwal	Coconut	*Cocos nucifera*
Condiments and spices:		
Timur		
Jwano	Carom	*Trachyspermum ammi*
Hing	Asafoetida	*Ferula foetide*
Sonph	Aniseed	
Khursani	Chilli	*Capsicum annuum*
Lasun	Garlic	*Allium sativum*
Besar	Turmeric	*Curcuma domestica*
Dhaniya	Coriander	*Coriandrum sativum*
Aduwa	Ginger	*Zingiber officinale*
Alainchi	Cardamom	*Elettaria cardamomum*
Tejpat	Bay leaf	*Cinammon* sp.
Methi	Fenugreek	*Trigonella foenum*
Marich	Pepper	*Piper nigrum*
Kagati Ko Bokra	Lime peel	*Citrus wedica*
Jaipatri	Mace	*Myritica fragrance*
Jaiphal	Nutmeg	*Myritica fragrance*
Bhakamilo	Bhakimilo	*Rhus javanica*
Lwang	Cloves	*Eugenia caryophylla*
Jeera	Cumin	*Cuminum cyminum*
Fruits:		
Bedu		
Khanayo	Banyan tree fig	*Ficus begalensis*
Ainselu	Himalayan yellow raspberry	*Rubus ellipticus*
Katuns	Chestnut	*Castranopsis hystrix*
Kaphal	Berry	*Myrica esculenta*
Chutro		*Berberis* sp.
Ghangharoo	Fire thorn	*Pyracantha crenulata*
Guyanlo		
Khjura	Date	*Phoenix* sp.
Ganeulee		
Amala	Amala	*Phyllanthus emblica*
Damaru		
Chiuri	Bassia	*Bassia butyracea* *Madhuca butyracea*

Local name	English name	Scientific name
Bhalayo		
Darim	Pomegranate	*Punica granatum*
Bel	Wood apple	*Limonia acidissima*
Mel/Mayal	Wild pear	*Pyrus pashia*
Naspati	Pear	*Randia aliginosa*
Kera	Banana	*Musa paradisiaca*
Mewa	Papaya	*Carica papaya*
Lapsi	Lopsi	*Choerospondias axillaris*
Syau	Apple	*Malus syvestris*
Khurpani	Apricot	*Prunus armeniaca*
Bans Ko Phal	Bamboo fruit	*Bambusa arundinacea*
Neem Ko Phal	Neem fruit	*Melia azadirachta*
Bayar	Zizyphus/Chinese date	*Zizyphus jujube* *Zizyphus mauritiana*
Hade Bayar	Aribel	*Zizyphus incurva*
Satibayar	Satibaya	*Rhus parviflora*
Angur	Grape	*Vitus vinifera*
Amba	Guava	*Psiidium guajava*
Rukh Katahar	Jackfruit	*Arcocarpus heterophyllus*
Jamun	Jambu	*Syzygium cumini*
Gulab Jamun	Rose apple	*Syzgium zambos*
Kusum	Kusum fruit	*Schleichera tijuga*
Badahar	Lakucha	*Artocarpus lakoocha*
Ban Kera	Wild banana	*Musa nepalensis*
Nibuwa	Lemon	*Citrus limon*
Jyamir		
Kagati	Lime	*Citrus auratnifolia*
Mausam	Sweet lime	*Citrus sinensis*
Bhogate	Pomelo	Citrus maxiena
Kaljyamir		
Bimiro		
Athannni		
Dowanni		
Lichi	Litchi	*Nephelium litchi*
Loquat	Loquat	*Eriobotray japonica*
Kimbu	Mulberry	*Morus alba*
Mahuwa	Mahuwa	*Bassia langifolia*
Aanp	Mango	*Mangifera indica*
Kharbuja	Muskmelon	*Cucumis melo*
Tarbuja	Watermelon	*Citrullus vulgaris*
Mewa	Papaya	*Carica papaya*
Katahar	Pineapple	*Ananus comosus*
Anar	Pomegranate	*Punica granatum*
Haluwabed	Persimmmon	*Diospyros kaki*
Suntala	Orange	*Citrus aurantium*
Aaru	Peach	*Amygdatis persica*
Aarubakhada	Plum	*Prunus domestica*
Peepal Ko Phal	Ficus fruit	*Ficus religiosa*
Seetahal/Saripha	Seetaphal	*Annona squamosa*
Bhui Kaphal	Strawberry	*Fragaria vesca*
Okhar	Walnut	*Juglans regia*
Kimbu	Mulberry	*Morus alba*
Fish:		
Katle Machha	Katla	*Catla catla*
Bam Machha	Bam	*Mastocembellus armatus*
Sahar Machha		
Mungri Machha	Magur	*Clarias batrachus*
Jhinge Machha	Prawan	*Penaeu* sp.
Rahoo Machha	Rahoo	*Labeo rohita*
Singhi Machha	Singhi	*Saccobvanchus fossils*
Tengra Machha	Tengra	*Mystus vitattus*

Local name	English name	Scientific name
Hilsa	Hilsa	*Clupea ilisha*
Jalakapur		
Nadi Ko Machha	Rainbow trout	
Gangata	Crab	*Paratephusa spinigera*
Meats:		
Boka/Bakhra/Khasi	Goat	*Capra hyrchusb*
Bheda	Mutton	
Ranga	Buffalo	*Balbus busbolis*
Kukhura	Fowl	*Gallus bankiva murghi*
Hans	Duck	*Anas platyrhyncha*
Bagedi	Finch	*Fringillidoe* sp.
Battain	Quail	
Parewa	Pigeon	*Columbalivia intermedia*
Sungur	Pork	*Sus cristatus wagemer*
Sano Chiplekira	Small snail	*Viviparus bengalensis*
Thulo Chiplekira	Big snail	*Pilaglobosa* sp.
Kachhuwa	Turtle	*Lissemys punctata*
Harin	Venison	*Antelope cervicapralinn*
Kaleej		
Teetra		
Chyakhura		
Dhukur		
Bhyakur		
Milk and milk products:		
Aama Ko Dhudh	Human milk	
Gai Ko Dhudh	Cow milk	
Bhainsi Ko Dhudh	Buffalo milk	
Bakhri Ko Dhudh	Goat milk	
Dahi	Yoghurt	
Mahi	Butter milk	
Gaale/Chenna		
Khuwa		
Chhurpi/Dudhkhuwa		
Cheese		
Dhulo Dhudh	Powdered milk	
Makk		
Fats and edible oils:		
Makkhan/Nauni	Butter	
Gai Ko Ghyu	Cow ghee	
Bhainsi Ko Ghyu	Buffalo ghee	
Chiuri Ko Ghyu	Hydrogenated oil	
Tori Ko Tel	Mustard oil	
Bhtamas Ko Tel	Soybean oil	
Suryamukhi Ko Tel	Sunflower oil	
Boso	Animal fat	
Miscellaneous foods:		
Maha	Honey	
Supari	Arecanut	*Areca catechu*
Pan Ko Pat	Betel leaves	*Piper betle*
Ookhu	Sugar cane	*Saccharum officinarum*
Nariwal	Coconut	*Cocos nucifera*
Badam Ko Pina	Groundnut cake	*Arachis hypogaea*
Gundruk	Gundruk	*Brassica* sp.
Katahar Ko Biyan	Jackfruit seed	*Artocarpus interidfolio*
Sakkhar/Gun	Jaggery	
Mahuwa	Mahuwa flower	*Bassia latifolia*

Source: Collected and compiled by Dr Shiddi Ganesh Shrestha, Kathmandu, Nepal. E-mail: shiddis@yahoo.com

Table 2. Nutritive value of some food crops of Nepal (all values in 100 gm of edible portion)

Crop	Protein, gm	Fat, gm	Mineral, gm	Carbo hydrate, gm	Energy, Kcal	Ca, mg	P, mg	Iron, mg	Carotene, mg	Thiamine, mg	Riboflavin, mg	Niacin, mg	Vit C, mg
Barley	11.6	5.0	2.3	67.5	361	42	296	8.0	132	0.33	0.25	2.3	0
Buckwheat	10.3	2.4	2.3	65.1	323	64	355	3.5	0	0.90	0.34	4.4	0
Foxtail Millet	12.3	4.3	3.3	60.9	331	31	290	12.9	32	0.59	0.11	3.2	0
Jowar	10.4	1.9	1.6	72.6	349	25	222	5.8	47	0.37	0.13	3.1	0
Oatmeal	13.6	7.6	1.8	62.8	374	50	380	3.8	0	0.98	0.16	1.1	0
Finger millet	7.3	1.3	2.7	72.0	328	344	283	3.9	42	0.42	0.19	1.1	0
Sorghum millet	7.6	2.4	1.0	74.7	357	17	196	3.6	0	0.10	0.03	3.0	0
Uwa white	12.61	1.6	2.1	70.5	346	25	0	4.12	-	-	-	-	-
Uwa black	10.39	1.75	2.33	70.9	340	20.30	-	7.48	-	-	-	-	-
Blackgram dal	24.0	1.4	3.2	59.6	347	154	385	3.8	38	0.42	0.20	2.0	0
Green g ram dal	24.5	1.2	3.5	59.9	348	75	405	3.9	49	0.47	0.21	2.4	0
Horse gram	22.0	0.5	3.2	57.2	321	287	311	6.77	71	0.42	0.20	1.5	1
Khesari Dal	28.2	0.6	2.3	56.6	345	90	317	6.3	120	0.39	0.17	2.9	0
Rajma	22.9	1.3	3.2	60.6	346	260	410	5.1	-	-	-	-	-
Cowpea	22.86	1.56	3.59	56.08	329.8	9	-	-	-	-	-	-	-
Banana rhizome	0.4	0.2	1.4	11.8	51	25	10	1.1	16	0	0.03	0.2	1
Beetroot	1.7	0.1	0.8	8.8	43	18	55	1.19	0	0.04	0.09	0.4	10
Colocacia	3.0	0.1	1.7	21.1	97	40	140	0.42	24	0.09	0.03	0.4	0
Garlic dry	6.0	0.1	1.0	29.8	145	30	310	1.3	-	0.06	0.23	0.4	13
Ghar T arul (yam)	4.07	0.07	2.06	32.6	147	69.8	-	24.03	-	-	-	-	-
Githa	3.72	0.94	0.93	25.19	124	12.41	-	0.95	0	-	-	-	-
Lotus root	1.70	0.10	0.20	11.3	53	21	74	0.40	-	0.10	-	-	22
Rani vykur	2.29	0.16	1.49	22.71	101	24.71	-	8.38	-	-	-	-	-
Sweet potato	1.20	0.30	1.0	28.2	120	46.0	50	0.21	6	0.08	0.04	0.7	24
Turnip	0.5	0.20	0.6	6.2	29	30	40	0.4	0	0.04	0.04	0.5	43
Turnip red	1.15	0.16	0.70	8.17	38.72	47.67	35.22	2.27	1.24	-	-	-	-
Elephant yam	1.2	0.10	0.8	18.4	79	50	34	0.6	260	0.06	0.07	0.7	-
Yam wild	2.5	0.30	1.4	24.4	110	20	74	1.0	97	0.19	0.45	0.2	1
Bitter gourd	1.6	0.20	0.8	4.2	25	20	70	0.61	126	0.07	0.09	0.5	88
Bottle gourd	0.2	0.12	0.5	2.5	12	20	10	0.46	0	0.03	0.01	0.2	0
Broad bean	4.5	0.10	0.8	7.2	48	50	64	1.4	9	0.08	-	0.8	12
Cluster bean	3.2	0.40	1.4	10.8	16	130	57	1.08	198	0.09	0.03	0.6	49
Colocacia stem	0.3	0.30	1.2	3.6	18	60	20	0.5	104	0.07	0.07	0.1	3
Pink bean	3.1	0.4	0.6	7.0	44	54	70	1.5	453	0.06	0.02	0.6	12
Rape stem	3.1	0.1	1.4	4.0	29	100	100	1.2	-	-	-	-	-
Ridge gourd	0.5	0.1	0.3	3.4	17	18	26	0.39	33	-	0.01	0.2	5
Snake gourd	0.5	0.3	0.5	3.3	18	26	20	1.51	96	0.04	0.06	0.3	0
Spinach stalk	0.9	0.1	1.8	3.8	20	90	20	1.6	-	-	-	-	3
Sword bean	2.7	0.2	0.6	7.8	44	60	40	2.0	24	0.08	0.08	0.5	12
Tinda tender	1.4	0.2	0.5	3.4	21	25	24	0.9	13	0.04	0.08	0.3	18
Barela	0.99	0.26	0.81	6.72	33.18	144	51	2.0	-	-	-	-	7
Sponge gourd	1.03	0.11	0.35	4.99	26.43	28.20	30.07	1.18	-	-	-	-	5
Winged bean tender	2.66	0.34	0.76	7.85	45.10	26.32	51.07	-	-	-	-	-	3.37
Linseed	20.3	37.1	2.4	28.9	530	170	370	2.7	30	0.23	0.07	1.0	0
Mustard seed	20.0	39.7	4.2	23.8	541	490	700	7.9	162	0.65	0.26	4.0	0
Niger seed	23.9	39.0	4.9	17.1	515	300	224	56.7	-	0.07	0.97	8.4	0
Walnut	15.6	64.5	1.8	11.0	687	100	380	2.64	6	0.45	0.40	1.0	0
Cardamom	10.2	2.2	5.4	42.1	229	130	160	4.6	0	0.22	0.17	0.8	0
Coriander	14.4	16.1	4.4	21.6	288	630	393	7.1	942	0.22	0.35	1.1	0
Fenugreek seed	26.2	5.8	3.0	44.1	333	160	370	6.5	96	0.34	0.29	1.1	0
Ginger fresh	2.3	0.9	1.2	12.3	67	20	60	3.5	40	0.06	0.03	0.6	6
Lime peel	1.8	0.5	1.8	29.4	129	710	60	2.7	-	-	-	-	-
Turmeric	6.3	5.1	3.5	69.4	349	150	282	67.8	30	0.03	0	2.3	0
Amala	0.5	0.1	0.5	13.7	58	50	20	1.2	9	0.03	0.01	0.2	600
Bael fruit	1.8	0.3	1.7	13.8	137	85	50	0.6	55	0.13	0.03	1.1	8
Banyan t ree fig	1.7	2.0	1.9	11.8	72	364	43	-	-	-	-	-	-
Figs	1.3	0.2	0.6	7.6	37	80	30	1.0	162	0.06	0.05	0.6	5
Mulberry	1.1	0.4	0.6	10.3	49	70	30	2.3	57	0.04	0.13	0.5	12

Crop	Protein, gm	Fat, gm	Mineral, gm	Carbo hydrate, gm	Energy, Kcal	Ca, mg	P, mg	Iron, mg	Carotene, mg	Thiamine, mg	Riboflavin, mg	Niacin, mg	Vit C, mg
Persimon	0.7	0.2	0.3	7.9	76	15	20	0.3	2268	0.03	0.01	0	35
Pomelo	0.6	0.1	0.5	10.2	44	30	30	0.3	120	0.03	0.03	0.2	20
Raspberry	1.0	0.6	0.9	11.7	56	40	110	2.3	1248	-	-	0.8	30
Custard apple (sitaphal)	1.6	0.4	0.9	23.5	104	17	47	4.31	0	0.07	0.17	1.3	37
Strawberry	0.7	0.2	0.4	9.8	44	30	30	1.8	18	0.03	0.02	0.2	52
Tree tomato	1.5	0.2	1.2	6.7	35	12	46	1.0	324	0.11	0.06	2.1	0
Ziziphus	0.8	0.3	0.3	17.0	74	4	9	0.5	21	0.02	0.05	0.7	76
Red raspberry	1.72	1.0	0.43	8.2	40.6	21.92	-	-	-	-	-	-	-
Lapsi	0.50	0.18	0.50	17.49	73.6	219	20.62	2.67	-	-	-	-	48.15
Snail small	12.6	1.0	3.8	3.7	74	1321	147	-	0	-	-	-	-
Snail big	10.5	0.6	2.4	12.4	97	870	116	-	-	0.54	-	-	-
Bam fish	16.1	0.9	1.3	6.9	100	330	240	0.8	-	-	-	0.3	3
Crab small	11.2	9.8	4.6	9.1	169	1606	253	-	-	-	-	-	-
Katle fish	19.5	2.4	1.5	2.9	11	530	235	0.9	-	-	-	0.8	-
Mungri fish	15.0	1.0	1.3	4.2	86	210	290	0.7	-	-	-	0.5	11
Rahu	16.7	1.4	0.9	4.4	97	650	175	1.0	0	0.05	0.07	0.7	22
Singhi fish	22.8	0.6	1.7	6.9	124	670	650	2.3	-	-	-	0.8	9
Tengra fish	19.2	6.4	2.1	2.3	144	270	170	2.0	-	-	-	-	18
Asparagus	2.1	0.3	0.7	3.8	27	22.5	-	-	-	-	-	-	20.87
Ban T arul (wild yam)	1.7	0	3.1	17.7	77	43	-	42.99	-	-	-	-	5.45
Bethe saag	7.1	trace	3.6	8.8	64	400	-	-	3334.3	-	-	-	-
Chutro	2.5	6.9	1.0	1.4	16.2	87	-	-	-	-	-	-	-
Guyelee	4.6	0.7	1.0	17.9	96	70.2	-	-	-	-	-	-	1.6
Halhale Saag	3.1	0.3	1.3	3.8	31	76.6	-	-	-	-	-	-	9514
Kali Mayal	0.7	trace	0.7	21.3	89	-	-	-	-	-	-	-	-
Kane Saag	2.3	0.1	1.6	1.7	3.2	23	821	53.13	7	3116	-	-	14.30
Khaneu	1.4	0.3	1.3	5.6	31	181	-	-	-	-	-	-	-
Koiralo	1.0	3.4	2.0	8.1	54	76	-	-	-	-	-	-	-
Kukur Daino	1.6	trace	0.6	1.2	2.8	17	20	2.7	-	-	-	-	3.7
Latte S aag green stem	6.4	trace	0.6	2.8	17	20.1	2.7	-	-	-	-	-	3.7
Latte S aag red stem	4.4	trace	2.9	9.5	48	-	-	-	-	-	-	-	-
Lude Saag	4.7	0.2	2.8	7.1	49	406	-	-	-	-	-	-	-
Mayal	0.4	0.2	0.4	16.2	68	-	-	-	-	-	-	-	-
Neuro (fern)	4.4	0.2	1.3	4.2	36	17.53	3.95	-	44.27	-	-	-	-
Buckwheat leaves	3.9	0.1	1.9	3.8	12	-	-	-	-	-	-	-	3.56
Pudina (mint)	4.5	trace	1.9	4.6	38	-	-	-	3677	-	-	-	16.14
Rato Tarul	1.9	0.1	0.7	2.3	100	76.92	45.91	1.69	34.23	-	-	-	3.27
Sati Bayar	2.8	0.5	2.0	32.2	142	170.5	-	-	-	-	-	-	-
Sisnoo (stinging nettle)	6.9	0.2	4.2	5.0	53	981.3	-	-	-	-	-	-	5.5
Tarul Munta	2.8	0.1	1.1	5.0	33	-	-	-	-	-	-	-	16.6
Thotne	221.5	0.3	0.8	5.8	29	27.7	-	-	-	-	-	-	6.22
Vyakur	1.6	0.05	0.6	-	-	-	-	-	-	-	-	-	6.19
Vyakur Githa	2.0	trqce	0.9	14.0	66	-	-	-	-	-	-	-	7.51
Vyakur Jhutre	1.5	-	0.8	18.0	78	-	-	-	-	-	-	-	6.94

Source: Agriculture Development Department (1994).

Edible wild plants of Bhutan and their contribution to food and nutrition security

Kinlay Tshering,[1] Laxmi Thapa,[2] Ken-ichi Matsushima,[3] Mineo Minami[4] and Kazuhiro Nemoto[5]

The study on the edible wild plants in Bhutan was initiated to discover the availability, distribution and use of edible wild plants in Bhutan and also to take stock of the indigenous knowledge about the effect of edible wild plants on human health. Five surveys were carried out (April 2005, April 2006, July 2007, October 2009 and May 2009) in different villages, markets, research centres and forests. From the availability point of view, species under Pteridophyta *are the most common edible wild plants. Many documented plants are believed to contain medicinal properties and have positive effects on human health. The Bhutanese link bitter-tasting foods with medicinal properties, therefore, they prefer bitter foods that are made from various plant parts. However, the purported health benefits of these edible wild plants have never been scientifically evaluated. Therefore, there is a need to look into their functional components.*

Keywords: Edible wild plants, traditional knowledge, human health, medicinal properties, Bhutan

Introduction

Owing to their high nutritional value, the culinary use of edible wild plants is increasing worldwide. They have become popular in European and Asian cuisines.

In Bhutan, a wide range of edible wild plants is harvested and consumed. This contributes significantly to the nutritional health of rural people by providing the essential nutrients required for body growth and development and for prevention of diseases associated with nutritional deficiencies. Traditionally, rural farmers have made conscious efforts to preserve these plants around their homesteads, in crop fields and communal lands. It is clear that wild edible plants continue to play an important role in the Bhutanese diet.

However, over the past decade, the government's thrust towards commercialization and use of high-yielding varieties has started to undermine traditional utilization of indigenous vegetables. The diversity, availability and usage of edible wild plants are waning because of the cultivation of introduced crops, habitat change and rapid dietary changes among the population. Moreover traditional knowledge is being lost. This is further exacerbated by a lack of major research and extension efforts to improve husbandry and promotion of edible wild plant species. There is also growing ignorance among young people about the existence of these nutritionally-rich food sources. These factors could be attributed to

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increased incidence of nutritional deficiency disorders and diseases among the rural populace.

As undernutrition and malnutrition are widely prevalent in Bhutan and felt more acutely in rural areas, it is a concern that the import of vegetables and increased cultivation of improved vegetables by the Bhutanese may reduce the collection and dietary use of edible wild plants and more critically may replace them. It is feared that a reduction in their consumption will result in more nutrition-related disorders in rural areas and also a decrease in sustainable forest usage thus disrupting the coexistence of people and the forest and the loss of traditional knowledge in the near future.

In these contexts the study on making an inventory of the edible wild plants of Bhutan was conducted. The information generated from this study will be used as reference material for research and development in the future and contribute to the sustainable development and conservation of natural resources in Bhutan.

Objectives

The main objective of this study was to investigate the diversity of edible wild plants in Bhutan and their potentials. The study analysed the diversity, availability, distribution and usage of edible wild plants in Bhutan and also took stock of the indigenous knowledge of the effect of edible wild plants on human health. The most common edible wild plants and their uses are identified.

Methodology

Interviews and surveys were conducted on farm, at research centres and with various interest groups, followed by species identification. The first survey was carried out in April 2005 followed by an annual survey in different parts of Bhutan until May 2009. During the five-year period, 18 out of 20 *dzongkhags* (districts) in Bhutan were covered. There were five investigative interview sessions, each taking about two weeks' study in the field. The survey was carried out by a group of Bhutanese researchers from the Ministry of Agriculture and Forests and Japanese researchers from Shinshu University.

Farm survey

During the farm survey, farmers were interviewed about the local names of edible wild plants, palatable parts, cooking and eating methods, knowledge of health effects, sources, seasonal availability and the approximate prices for retail at the market. Whenever possible, elderly people were selected for the interview. The interview was followed by field observations of available specimens and samples were collected for proper identification by various specialists (from Bhutan and Japan) and storage in the gene bank of the National Biodiversity Centre under the Ministry of Agriculture and Forests, Bhutan.

Market survey

During the market survey, all the edible wild plants on sale in the vegetable market were listed. Vendors were then asked the same questions employed in the farm survey and samples were collected for gene bank storage.

Survey sites

Details of the survey sites are given in Table 1.

Table 1. Edible wild plant survey sites in Bhutan

Dzongkhag	**Survey site**
April, 2005	
Thimphu	Thimphu market (2 400 masl)
Punakha	Punakha market (1 220 masl)
Tsirang	Damphu market, Beteni village
Haa	Tokey village (2 940 masl)
April, 2006	
Trongsa	Drenshing village (2 090 masl)
	Trongsa market (2 100 masl)
Bumthang	Dhur market (2 685 masl); Jakar market (2 550 masl)
Mongar	Jangdung village (680 masl); Mongar garden (1 570 masl); Kilikhar forest (1 650 masl); Korila forest (1 950 masl); Wengkhar research. field (1 680 masl); Mongar market (1 570 masl); Lingmethang research field (670 masl)
Trashigang	Bikhar village (2 220 masl)
Zhemgang	Dhagkhar village (1 840 masl)
July 2007	
Haa	Chelela forest (3 800 masl); Talung village (2 940 masl)
Thimphu	Thimphu market (2 400 masl)
Punakha	Punakha market (1 220 masl); Chuda Zong forest (1 500 masl)
Wangduepho-drang	Bajo research field (1 200 masl); Wangduephodrang market (1 200 masl); Langejara village (2 205 masl); Wogaynal village (1 325 masl)
October 2008	
Chukha	Tala research field (1 700 masl); Meretsemo village, Bongo (1 350 masl); Phuntsholing market (250 masl); Toribari village, Phuntsholing (360 masl); Rangetung village, Sampheling (400 masl)
Dagana	Zamto village, Tseza (1 760 masl); Upper Goshi village, Goshi (1 400 masl); Phuntsumgang village, Goshi (1 400 masl)
Punakha	Punakha market (1 240 masl)
Gasa	Jashidingkha village, Khatoe (2 510 masl); Mani, Khatoe (2 600 masl); Baychurichoe village, Khatoe (2 100 masl); Damji Bara Legom village, Khame (2 230 masl)
May 2009	
Lhuntse	Jang village, Gangzur (1 820 masl)
Trashiyangtse	Dungzum village, Bomdeling (1 940 masl)
Samdrup-jongkhar	Ngalangshing village, Deothang (830 masl), Domphu village, Deothang (916 masl), Martang village, Deothang (629 masl)
Pemagatshel	Gamung village, Shumar (1 323 masl)
Thimphu	Thimphu market (2 400 masl)
Paro	Paro market (2 270 masl)

The scientific names and families of the specimens collected during the survey were identified by researchers, a taxonomist and a specialist. Previous research data with available photographs were also used.

Results and discussion

In April 2005, the investigation was carried out in Thimphu, Punakha, Tsirang and Haa. A total of 98 edible wild plants were recorded, including 30 wild plants and 68 cultivated plants. The collected wild plant species belonged to 21 families and the cultivated plant species belonged to 28 families. Among the edible wild plants, *Pogostemon amaranthoides* (Namna), *Phytolocca ac inosa* Roxb. (Tashi Gangkha) and *Elatostema lineolatum* Wight (Damroo), used as leafy vegetables, were frequently observed in the markets. The young stems of ferns were frequently sold and consumed as vegetables. In total, eight different kinds of ferns belonging to four families (*Microlepsia* sp.; *Pteridium revolutun* [BL.] Nakai; *Diplazium esculentum* [Retz.] Swartz; *Diplazium maximum* [Don] C. Christens) and four species of *Diplazium* were observed but some of the species could not be identified. Some wild species are believed to be beneficial to human health.

In April 2006, the investigation was carried out in Trongsa, Bumthang, Mongar, Trashigang and Zhemgang. A total of 47 edible wild plants belonging to 25 families of *Magnoliophyta* and a total of 12 edible wild plants belonging to *Pteridophyta* were determined. Common edible wild vegetables were *Justicia* a*dhatoda* L. (Bashikha), *Plectocomia h imalayana* Griff (Patsha), *Asparagus r acemosus* Willd (Ngakhagchu), *Phytolocca a cinosa* Roxb. (Tashi Gangkha), *Houttuynia c ordata* Thunb. (Gaycho), *Chenopodium album* L. (Henshu), *Mentha spicata* L. (Ushila), *Cymbiduim* sp. (Olachoto), *Pogostemon amaranthoides* (Namna), *Elatostema* lineolatum Wight (Damroo), *Oenanthe javanica* (Bl.) DC (Zeemtsi), *Colocasia esculenta* (L.) Schotts (Dow), *Thlaspi arvense* L. (Gekha) *Urtica dioia* (Zocha) and *Girardianan palmate* (Zocha).

In July 2007, the investigation was carried out in Haa, Punakha and Wangduephodrang. A total of 26 edible wild plants belonging to 19 families of *Magnoliophyta* and a total of ten edible wild plants belonging to *Pteridophyta* were determined. Some common plants were *Plectocomia himalayana* Griff (Patsha), *Elatostema* lineolatum Wight (Damroo), *Thlaspi arvense* L. (Gekha), *Chenopodium al bum* L. (Henshu), *Mentha s picata* L. (Ushila), *Cymbiduim* species (Olachoto), *Pogostemon am aranthoides* (Namna) and *Phytolocca acinosa* Roxb. (Tashi Gangkha).

In October 2008, the investigation was carried out in Chukha, Dagana, Punakha and Gasa. A total of 66 edible wild plants belonging to 33 families of *Magnoliophyta* and a total of 13 edible wild plant species belonging to four families of *Pteridophyta* were determined. Some of the wild edible plants are purported to have medicinal properties beneficial to human health. However, edible wild plants of *Pteridophyta* are purported to be harmful.

In May 2009, the investigation was carried out in Lhuntse, Trashiyangte, Pemagatshel, Samdrupjongkhar, Thimphu and Paro. A total of 78 edible wild plants belonging to 45 families of *Magnoliophyta* and a total of eight edible wild plant species belonging to three families of *Pteridophyta* were determined. Some of the wild edible plants are purported to have medicinal properties beneficial to human health while others are contra-indicative.

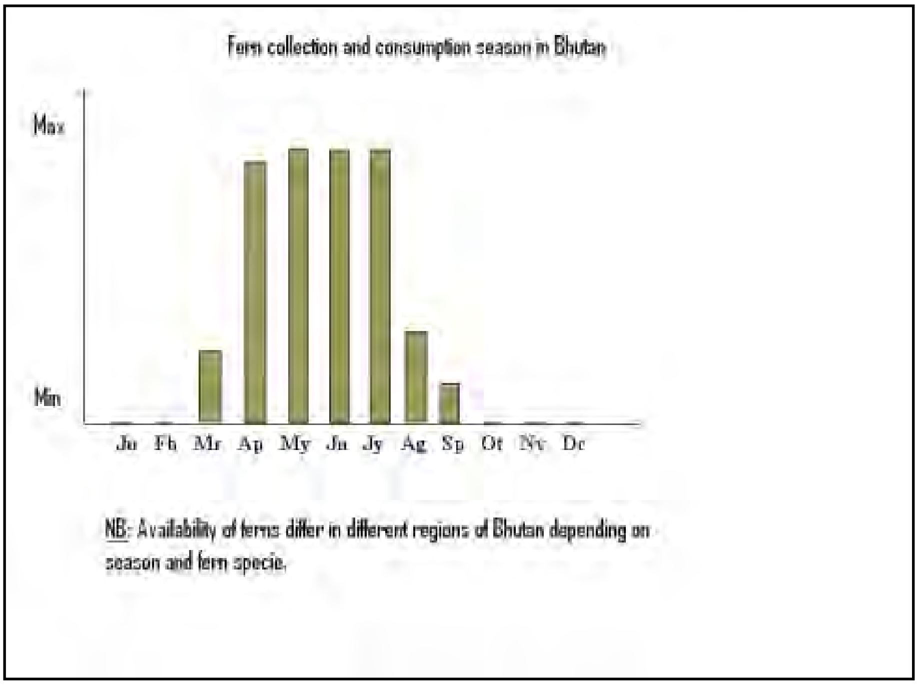
In the five years of investigation, a total of 108 edible wild plants belonging to 53 families of *Magnoliophyta* were found, out of which 101 species were identified; a total of 20 edible wild plants belonging to five families of *Pteridophyta* were determined out of which 15 species were identified.

Among the many edible wild plants, the most common that are widely distributed, collected, traded and consumed by the Bhutanese across the country as food are *Diplazium* sp. (Nakey), *Plectocomia himalayana* Griff (Patsha), *Elatostema lineolatum* Wight (Damroo), *Thlaspi ar vense* L. (Gekha), *Justicia* a*dhatoda* L. (Bashikha), *Asparagus racemosus* Willd (Ngakhagchu), *Phytolocca acinosa* Roxb. (Tashi Gangkha), *Houttuynia cordata* Thunb. (Gaycho), *Mentha s picata* L. (Ushila), *Cymbidium* sp. (Olachoto), *Pogostemon am aranthoides* (Namna), *Colocasia escu lenta* (L.) Schotts (Dow), *Bambusioideae* sp. (Pakshing), *Dioscorea* sp., *Nasturium o fficinale* (Sim Rayo) and *Girardianan pa lmate* (Zocha). Their edible parts and common usage are described in Table 2.

Table 2. Common edible wild plants in Bhutan

Plant	Edible parts	Common usage
Diplazium sp. (Nakey)	Fronds	Remove hairs, slice and cook with any meat or stir-fry with chilli. Cleaned, sliced and chopped pieces are also cooked with chilli and cheese in gravy. Straining before cooking is optional
Plectocomia himalayana Griff (Patsha)	Inner pith of young shoot	Take out the outer scales, cut into small pieces, boil, strain (optional) and then cook as any other vegetable
Elatostema lineolatum Wight (Damroo)	Young shoots & leaves	Cut into pieces and cook with chilli, onion, cheese. It goes well with *Plectocomia himalayana* and meat in a soup
Thlaspi arvense L. (Gekha)	Leaves and stems	Cut into pieces, boil, strain (optional) and cook with meat (optional), chilli and cheese. It can be stir-fried as well
Justicia adhatoda L. (Bashikha)	Flowers	Boil, strain (optional) and cook with meat (optional), chilli and cheese. It can be stir-fried as well
Asparagus racemosus Willd (Ngakhagchu)	Young shoots/ spears	Cut into pieces, boil, strain (optional) and cook with meat (optional), chilli and cheese
Phytolocca acinosa Roxb. (Tashi Gangkha)	Tender leaves and shoot tips	Cut into pieces and cook with meat (optional), chilli and cheese. It can be stir-fried as well
Houttuynia cordata Thunb. (Gaycho)	Tender leaves and roots	Cut into pieces and make into chutney with chilli, onion, garlic, ginger and salt. It is also eaten as a salad with chilli sauce
Mentha spicata L. (Ushila)	Leaves	Make into chutney with chilli, tomato, onion and salt. It is also used with different flour to make sausages
Cymbidium sp. (Olachoto),	Inflorescence	Cut into pieces, boil, strain (optional) and cook with meat (optional), chilli and cheese. It can be stir-fried as well
Pogostemon amaranthoides (Namna)	Leaves	Cut into pieces and cook with a little chilli, onion, cheese and oil/butter.– soup
Colocasia esculenta (L.) Schotts (Dow),	Rhizome and petal base	Boil the rhizome, peel the skin and eat as potatoes. Petal bases can be stir-fried as other vegetables
Bambusioideae sp. (Pakshing),	Tender shoots	Boil with ash, strain, then pickle or fry as vegetables with chilli, onion, etc.
Dioscorea sp.	Above- and underground tubers	Remove outer skin, cut into small pieces, boil with ash, wash again two times and eat as potato
Nasturium officinale (Sim Rayo)	Leaves and shoots	Fry as any other leafy vegetable
Girardianan palmate (Zocha)	Inflorescence and tender shoots	Cook with garlic, ginger, chilli and salt to make a thick soup

From the distribution and availability point of view, species under *Pteridophyta* (ferns) are the most common edible wild plants for most people in Bhutan (Figure 1). They are some of the most readily available and inexpensive plants in the markets, especially during spring/early summer up to the monsoon. This is true especially for the marginal farmers in the remote communities in Bhutan as the ferns can be collected very easily from the wild, where they grow in abundance, without paying any cost or royalty for both home consumption and cash income through sale in the local markets. Many families in remote Bhutan consume bracken for a very long period of time in the year. In some regions of the country ferns are considered delicacies and preferred over other vegetables which may be associated with traditional food habits.



1. Fern collection and consumption seasons in Bhutan

Various parts of plants, including leaves, stems, young stems, flowers, inflorescence, tubers, fruit and seeds were consumed for food. During spring and summer, the Bhutanese eat many kinds of edible wild plants as vegetables, indicating their importance in the Bhutanese diet.

Many of the recorded plants are believed to have medicinal properties and have positive effects on human health. For example, the leaves of *Nasturium officinalis* (Sim Rayo) improve blood quality, leaves of *Mentha spicata* L. and inflorescence of *Gerardiana* sp. lower blood pressure, leaves of *Urtica* sp. relieve tuberculosis and so forth. Similarly, there is much indigenous knowledge about the positive effects of other edible wild plants on human health. The Bhutanes link bitter taste in food with medicinal properties; therefore, they prefer bitter foods made from various plant parts such as flowers of *Adhatoda vasica* Ness (Bashikha), young stems of *Asparagus racemosus* Willd (Ngakhagchu), inflorescence of *Cymbidium* species (Olachoto) and young shoots of *Plectocomia himalayana* Griff (Patsha).

However, the purported health benefits of these wild edible plants have never been scientifically evaluated. Therefore, this is needs to be done. As an outcome of the study, the book *Edible wild plants of Bhutan and their associated traditional knowledge,* was published jointly by Shinshu University, Japan and the Ministry of Agriculture and Forests, Bhutan.

Conclusion

From the survey, it is clear that a wide range of wild edible plants can be found in Bhutan. They play a very important role for farmers both traditionally and economically. They are collected for consumption as well as for sale. These plants contribute to household food and nutritional security by providing a diversity of nutritionally-rich and pesticide-free foods that can be used on a daily basis. They can also be used as fall-back food provision during lean periods.

Farmers have good knowledge of their functional values and effects on human health. More importantly, most of the positive effects of edible wild plants on human health are believed to be associated with plants that have never been scientifically evaluated. The current survey results suggest that they may have great public health significance in terms of preventing disease, disability and premature mortality.

Considering the importance of edible wild plants for Bhutanese farmers, the need for a strategic approach to study them cannot be overemphasized. There is a need to evaluate the food value and value chain of edible wild plants and quantify their contribution to food and nutrition security. The long-term approach, among others, should focus on a nationwide survey and documentation of all the edible wild plants of Bhutan followed by species-led research and development. Research is needed to reconfirm local beliefs by scientifically analysing the functional components of the major edible wild plants that have an impact on health. This will also expand the nutritional database of these major edible wild plants, including possible anti-nutritional factors, as well as epidemiological studies to assess their role in promoting health and mitigating disease.

From healthy childhood to productive adulthood, and further on into robust old age, it is important to ensure good nutrition, which is a multisectoral responsibility due to the complexity of its determinants. Therefore, any option through wild collection or through cultivation of improved cultivars to secure people's nutritional well-being is required.

There is a need to develop a comprehensive package for the sustainable utilization of edible wild plants through proper assessment of existing situations/community requirements, designing appropriate monitoring and evaluation requirements, and continuously building capacity at all levels – for planners, researchers, extension workers and more importantly farmers.

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Sadamu Matsumoto, Senior Curator, Tsukuba Botanical Garden, National Museum of Nature and Science, Japan in identifying the *Pteridophyta* species. Last but not least, we also acknowledge the support of Dr Hironobu Shiwachi, Professor, Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture, Japan in identifying the *Dioscoreaceae* species.

Photo 1. Some common edible wild plants of Bhutan

***Elatostema lineolatum* Wight (Damroo)**

***Plectocomia himalayana* Griff (Patsha)**

***Diplazium esculentum* (Nakey)**

***Cymbidium erythraeum* (Olachoto)**

***Asparagus racemosus* Willd (Ngakhagchu)**

***Justicia adhatoda* L. (Bashikha)**

***Bambusioideae* species (Pashing)**

***Houttuynia cordata* Thunb. (Gaycho)**

***Nasturium officinale* (Sim Rayo)**

***Pogostemon amaranthoides* (Namna)**

***Phytolocca acinosa* Roxb. (Tashi Gangkha)**

***Thlaspi arvense* L. (Gekha)**

Photos courtesy Tshering

Wild mushrooms and their contribution to livelihoods and diet in Bhutan[1]

Dawa Penjor,[2] Sonam Peldon[3] and Meeta Punjabi[4]

The study was conducted to understand the role wild mushroom collection in the livelihoods of rural communities and the need for interventions to improve sustainability and marketing of the resource. Income and employment generated from the collection and sale of wild mushrooms contribute considerably towards poverty alleviation, conservation of the natural environment, preservation of culture and community organization. This is in line with the Bhutanese philosophy of Gross National Happiness. The study also pointed out inadequate support from government organizations in remote villages in terms of lack of staff, resources and infrastructure.

Keywords: Wild mushroom collection, livelihoods, rural communities, Bhutan

Background

The pro-poor Mushroom Commodity Chain Analysis was conducted as part of an initiative by the FAO-Netherlands Partnership Program (FNPP) to address Bhutan's food security issues. Various studies have also shown that poorer communities exhibit a higher dependence on mushrooms, particularly during the lean agricultural season for generating cash income and supplementing their general dietary requirements. This is particularly important in areas where agricultural activity is demanding owing to the altitude or terrain.

Mushrooms with the potential to generate rural income and rural development in Bhutan were selected for the study. The commodity was analysed in detail with a pro-poor focus using the Commodity Chain Analysis (CCA) methodology. The results of these analyses will help devise programmes for further development of this commodity to bolster food security in the country. The study focused on the wild mushroom commodity chain with special focus on matsutake mushrooms.

Rationale

The Government of Bhutan has identified non-wood forest product (NWFP) development as a major activity for poverty reduction and also as a means to achieve economic growth. Hence, poverty reduction is the main development priority for the Tenth Five Year Plan. Over the last decade, the importance of NWFPs for income generation, food security and biodiversity conservation had been widely acknowledged in Bhutan.

In Bhutan, all NWFPs are legally under direct state authority but often without effective management. With expanding demand for NWFPs, they will eventually be overexploited with negative impacts on livelihood security.

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1 The contents of this paper have been abridged for inclusion in this publication.
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Wild edible mushrooms have always been collected and consumed by rural communities in Bhutan, the most popular being matsutake, chanterelle, shiitake, oyster, shimeji and wood ear (*Auricularia* spp.) varieties, among others. In view of the difficult terrain and the small landholdings, mushroom collection (wild and cultivated) is an important activity for cash income and sustaining livelihoods. The market demand for mushrooms is growing every year.

Mushroom collection or cultivation is also in line with the four pillars of the government's Gross National Happiness (GNH) policy. In this context Bhutan has embarked on (a) sustainable socio-economic development; (b) conservation of the environment; (c) preservation and promotion of cultural values; and (d) good governance. Conserving mushroom forests also means protecting the environment. Income from the sale of mushrooms has also contributed to mitigating rural-urban migration besides sustaining the economic viability of many rural communities. Community management of natural resources is helping people to work together.

Despite the importance of mushrooms in the livelihoods of the poor, very little scientific research has been undertaken to understand their importance in rural incomes as well as issues relating to collection, marketing and natural resource management. Some studies have been conducted on the matsutake mushroom, as it is a high value export crop. However, overall there is a need to take a closer look at the current situation to devise an appropriate strategy for the future.

Objectives

The general objective of the study was to examine wild mushroom collection and marketing in Bhutan. The specific objectives were:

- Understanding how collection and marketing is conducted;
- Analysing the availability of natural resources and related constraints;
- Best approaches for managing mushrooms in the future;
- Ensuring access to resources and quantification;
- Identifying value-addition potential for mushrooms;
- Developing a growth strategy for the commodity based on analysis of the current scenario and emerging trends.

For conducting a CCA it is necessary to analyse agents at every level in the chain. However for most species there were few agents. Only matsutake mushrooms had specific intermediaries working with collectors and exporters. For the other mushroom varieties, profitability analysis was done at the farm level.

Methodology

The CCA methodology addressed understanding the various aspects of the commodity chain and suggesting possible remedies to address the issues that emerged. Analysis components included:

- ***Functional analysis:*** Identified the agents involved in the mushroom chain and their roles. These agents comprised input suppliers to downstream exporters, retailers and other stakeholders.
- ***Flow analysis:*** Provided insights into the subchannels and commodity flow through these channels. This gave an idea of how total production in the country is utilized – home consumption, gift exchange, sale in domestic and export markets.

- ***Technical and gap analysis:*** Provided information on the constraints and technical gaps across the chain from input supply, production, postharvest handling to processing and marketing.

- ***Micro-analysis at the operator level:*** Provided a detailed description of the activity at each level in the chain. This analysis also included financial analysis of every agent in the chain giving a clear picture of the costs incurred and revenues generated and hence, the profits at each level.

  This analysis also formed the basis for understanding the impact of government policies using simulations along with information on economic and financial prices and returns. The economic prices and returns were related to home labour and consumption, whereas the financial prices and returns were based only on actual financial transactions, such as money spent on purchasing inputs, and returns from market sales.

- ***Economic and social impact of the chain:*** This indicated the value of the chain from the perspective of the sector's importance to the economy. The analysis highlighted the total number of households dependent on this chain, employment statistics and total value generated, distribution of the value generated among the participants and the degree of vulnerability of the households in this chain.

Overview of edible mushroom species in Bhutan

Bhutan prizes its wide variety of mushrooms. More edible mushroom varieties are found in temperate regions than in tropical areas. Some of the commonly consumed mushrooms are listed in Table 1. Many varieties are marketed commercially, particularly at the domestic level.

The matsutake mushroom is a high value mushroom exported to Japan. In 2011 over 2 tonnes of fresh matsutake mushroom were exported with an estimated value of US$100 000 but in the mid-1990s, export *per annum* exceeded 11 tonnes. This decline is attributed to competition from abroad and difficulties in transportation from Bhutan. Although export quantity has declined, domestic demand has been increasing.

Geney County in Thimphu District is the most popular location for trade in this commodity but markets are also found in Haa, Paro, Lunana and Bumthang districts, all of which are high altitude areas where agricultural production is very low.

Table 1. Some of the important edible mushrooms collected in Bhutan

Common name/local name	Scientific name
Matsutake/Sangay Shamong	*Tricholoma matsutake*
Chanterelle/Sese Shamong	*Cantherellus cibarius*
Oyster mushroom/Naki Shamong	*Pleorotus ostreatus*
Shiitake mushroom/Soke Shamong	*Lentinula edodes*
Shimeji/Ngala Shamong	*Lyophyllum shimeji*
Wood Ear/Bjili Namcho	*Auricularia auricula*
Coral mushroom/Bjichu Kangru	C*lavaria* spp,
Short Stem Russula/Gah Shamong	*Russula delica*
Gypsy/Dhungshing Shamong	*Rozites caperata*

Geney County has formed a community organization for sustainable harvesting of wild mushrooms. Resource-use rights and rules are well established there. The community has organized itself to manage the sustainable harvesting of mushrooms, preservation of the mushroom environment, including host trees, and group marketing. To strengthen the community organization, the National Mushroom Center (NMC) has provided training on sustainable harvesting of mushrooms for local mushroom collectors. The NMC also fixes the season for matsutake mushroom harvesting to allow mushrooms to mature in the forest − 1 August to 30 September. The local forest officer helps to control the management system and records the amount of mushrooms harvested and sold, and ensures that undersized mushrooms are not harvested.

Data collection

For the CCA exercise, surveys on households, retailers, consumers, agents and exporters were carried out in seven districts: Thimphu (Geney), Gasa (Laya), Paro (Dotey), Punakha (Kabjisa), Wangdiphodrang (Bjena), Bumthang (Ura) and Chukha (Bongo).

Although many varieties of mushrooms are found in the country only those that have domestic and commercial importance were analysed in the CCA: matsutake (*Tricholoma matsutake),* chanterelle (*Cantarellus c ibarius*)*,* oyster mushroom (*Pleorotus o streatus*), shimeji (*Lyophyllum shimeji*) and shiitake mushroom (*Lentinula edodes*).

Tables 2 and 3 provide details of the survey area and demographic details of respondents.

Table 2. Mushroom producers interviewed

District	No. of households interviewed
Gasa (Laya)	30
Thimphu (Geney)	30
Paro (Dotey)	25
Punakha (Kabjisa)	15
Wangdiphodrang (Bjena)	10
Bumthang (Ura)	30
Chukha (Bongo)	10
Total no. of farmers interviewed	**150**

Table 3. Household size by gender and age group

Gender and age group	Average
Male adult (>15 yrs)	2.6
Female adult (>15 yrs)	2.8
Children (<15 yrs)	2.9
Total	**8.4**

Results

Matsutake mushroom are graded into two categories, Grade A and Grade B. The prices are Nu.450/kilogram for Grade A and Nu.100/kilogram for Grade B. The Grade A matsutake mushroom fetches US$70-100/kilogram on the international market.

The individual farmer's income from the sale of matsutake mushroom is highly variable depending upon experience and the presence of able-bodied family members. In the mushroom collection season, income varies from Nu.1 000[5] to Nu.85 000. In 2006 many farmers reported income within the range of Nu.5 000 to Nu.75 000 per season.

The farmers in Ura and Shingkhar in Bumthang District are also highly dependent on mushroom collection for cash income and employment. There is an opportunity for promoting postharvest processing, packaging and product development of matsutake mushroom as Bumthang is far from the capital. Income in 2006 was within the range of Nu.200 to Nu.20 000 per season.

Table 4 shows the share of income from mushrooms and agriculture in the average annual income per county. Almost half of the income comes from mushrooms in Geney although mushrooms are a seasonal commodity.

Table 4. Share of income from mushroom collection and agriculture

County	Ave.income (Nu.)	% income from mushrooms	% income from agriculture
Geney	48 426	43	58
Dotey	47 221	20	63
Kabjisa	6 493	27.5	23.9
Bjena	22 788	27.5	82
Ura	55 816	12	81
Chukha	5 913	13	38

Figure 1 shows income from mushrooms and agriculture categorized into Low, Medium and High groups where low is less than Nu.24 000 per year, Medium is less than Nu.50 000 per year and High is more than Nu.50 000

[5] US$1.00 = Nu.55.1450 (July 2012).

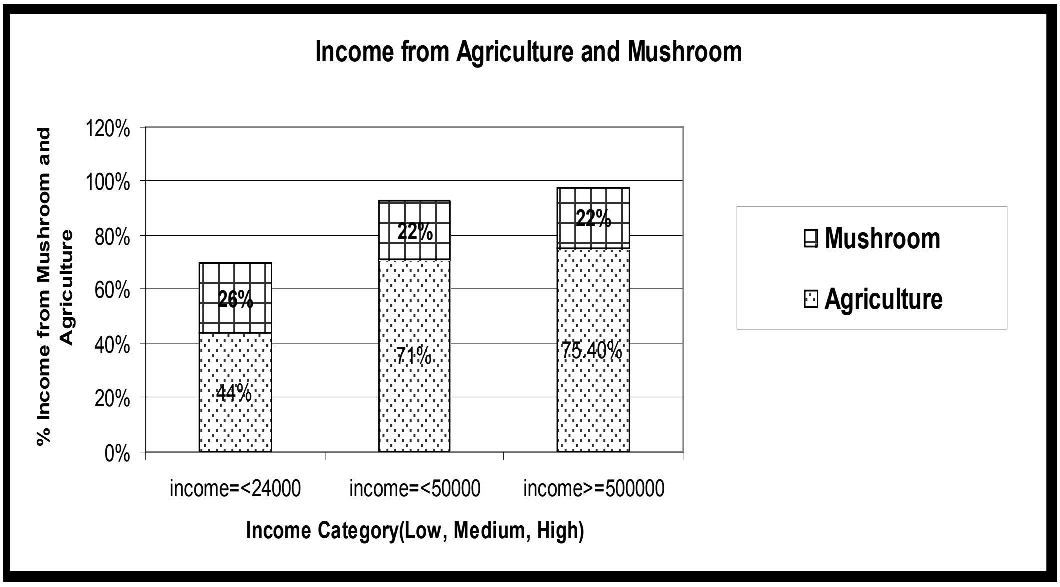

Figure 1. Income from agriculture and mushroom collection

All households engage in matsutake mushroom collection and sale during the collection season. Collection and sale of matsutake mushroom is the most important source of cash income for almost all families in most high altitude areas. Farming is highly subsistent in nature with small landholdings on mostly dry land and rugged terrain. The cash earned from matsutake mushrooms in these communities is utilized to meet household needs that include:

- Children's education;
- Purchasing household items and clothing;
- Purchasing farm tools and machinery;
- Purchasing oxen for ploughing;
- Purchasing corrugated iron sheets for roofing;
- Purchasing fences to protect crops.

Among the five varieties of mushrooms analysed in this study, only matsutake mushrooms are exported to international markets. In the 20 years since commercial collection and export-oriented trade in matsutake mushroom began, it has become a mainstay of the economy in Geney.

Chanterelle, shiitake and oyster mushrooms are destined for the local market. The most favoured varieties for home consumption are shimeji in Ura; matsutake in Geney, Dotey and Laya; and shiitake in Chukha, Bjena and Kabjisa. Home consumption also varies based on mushroom availability, taste and distance to resources.

Growth strategy

The growth strategy has been developed along the four axes of the Bhutan National Food Security Plan:

1) Enhance and stabilize production;
2) Increase access to markets;
3) Generate employment opportunities; and
4) Minimize the risks to production.

The functional and flow analysis as well as the analysis of technical performance and gaps provided insights into the issues and constraints in production and marketing of mushrooms. This information was used to develop the growth strategy, part of which is presented in Table 5.

Table 5. Growth strategy for the matsutake mushroom value chain

National Food Security Plan	Strategic areas of intervention	Specific activities for supporting the mushroom chain	Specific support policies
Enhance and stabilize domestic food production	Promote technical input	▪ Support group formation for technical training ▪ Immediate need to mobilize skilled researchers in this region to further area-based research ▪ Formation of a regional Mushroom Unit of the NMC	Ensure adequate funds and human resources
	Enhance natural resource management methods	▪ Propagate mitigation techniques for sustainable management of resources ▪ Enhance capacity of staff working with mushrooms	
	Forest resource management	Reduce the royalty paid for mushrooms to increase transparency; hence more information about market transactions becomes available (help to develop a strategy for sustainable harvesting and more market information for planning)	
Increase access to markets	Improve processing and marketing	▪ Support farmer groups for collection, postharvest management and marketing ▪ Procure relevant driers for processing ▪ Support to set up micro-enterprises for mushroom processing, packaging and marketing through farmer groups for commercial viability ▪ Encourage group certification by farmers through a Group Certification System to encourage exports ▪ Support promotional activities like ecotourism and organizing Matsutake dinners by hoteliers	▪ Technical and financial support for farmer groups ▪ Introduce affordable credit facilities for private operators

SWOT analysis

A Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was conducted to review the status of mushroom collection by rural communities and to complement the objectives of the National Food Security Plan. The results are given in Table 6.

Strengths	Weaknesses
• Forest laws/by-law in place. Clear collection rights (by royal command in the 1980s) • Available market for mushrooms • Low production cost • Favourable climatic conditions • Tshogpa - existing and functional traditional community institution (social capital)	• Unorganized collectors. • Low price for collectors • Insufficient data on production; inadequate information on the upper level value chain • Unsustainable harvesting – unstable prices; insecure market • Inefficiency in service delivery systems • Inadequate capital base – constraining product diversification; access to credit
Opportunities	**Threats**
• Comparative advantage – considered to have more medicinal value; • Product diversification/ differentiation – drying; canning; pickle making • Explore alternatives for domestication via further research • Cooperative Act – legal back-up for organizational activity	• Deforestation – loss of host trees • Unsustainable harvesting of mushrooms • Lack of coordination between concerned departments

Recommendations

Potential supply target: The collection of matsutake mushroom could reach 7 tonnes or more if adequate processing facilities were available; remote areas could be explored.

Role of the NMC: As the NMC is located in the capital it is not able to cater to farmers' needs, especially in remote areas. Establishing Regional Mushroom Units and improving the capacity at the centre could address this issue.

Management of resources: Mushroom resources are declining because there are too many local collectors and because of intrusion by outsiders in some mushroom-growing areas. Efficient group resource management, as found in Geney could be adopted by other mushroom collectors, i.e. stipulating time limits for collection during the day.

Postharvest losses: Postharvest losses occur mainly due to rotting. There is a need for increased involvement of exporters in postharvest management and also to address issues in the export market regarding quality and packaging materials.

Marketing: As mushrooms are a perishable commodity, retailers should not only try to sell fresh mushrooms but also explore product diversification for international as well as internal markets. Communities should focus on group marketing, explore the internal market and identify mushroom prices in the export markets. They should explore options for creating marketing linkages with institutions; this is where the Agriculture Marketing Section of the NMC and the private sector should play a role in bridging the gap between the collectors and the export markets.

Forest resource management: Reducing the royalty paid for mushroom collection could increase transparency; hence more information about market transactions would become available. This will in turn help to develop a strategy for sustainable harvesting and more market information for planning for the future.

Community natural resource management: Transferring the experience of community mushroom management to other districts in the country could help conservation of the natural environment and sustainable harvesting and marketing of mushrooms.

CHAPTER 2

The importance of recording local knowledge about edible insects in Oceania with particular reference to Australia

Alan Louey Yen[1]

A diverse range of insects and other invertebrate species is eaten by traditional peoples in Oceania. With increasing globalization, there is a tendency to use less traditional foods, and there is the danger that traditional knowledge about these foods will be lost. There is a very strong link between the environment, health, traditional food and culture among Australian Aborigines. The increased use of traditional foods, including insects, could result in better management of the environment, stronger cultural ties and improved health among Aborigines who suffer chronic health problems because of introduced foods and less active lifestyles. There is an opportunity to form partnerships between traditional peoples and western science to establish small commercial indigenous ventures to semi-domesticate edible insects for their own use and for commercial purposes. The issues in Australia are just as relevant and important in the adjacent nations in Oceania.

Keywords: Edible insects, shellfish, Australia, Aborigines, Oceania, semi-domestication

Introduction

With increasing globalization, there has been a reduction in the use of traditional foods by many societies across the world. Associated with this reduced use is a loss of knowledge relating these foods to their environment, the nutritional and medicinal values associated with them, how they are collected, stored and prepared, and often overlooked, loss of cultural values associated with them. Kuhnlein *et al.* (2009) define 'traditional foods' as foods that indigenous peoples have access to locally in the natural environment that they can farm or wild harvest without having to purchase them.

In Australia, the term 'traditional foods' usually conjures visions of Aborigines hunting kangaroos, and less often, birds, fish and lizards. However the range of foods utilized by Australian Aborigines is much greater than this; plants (green parts, fruit, tubers and seeds) contribute to over half their diet, and they also utilize fungi, insects, crustacea and molluscs.

Most of the literature on the insect diet of Australian Aborigines suggests that a few well-known species were exploited throughout Australia: witjuti and bardi grubs, honey ants, Bogong moths and lerps are the commonly listed species. This does not take into account the diversity of species utilized, geographical differences in the species used and confusion caused by applying a common name (such as 'witjuti' and 'bardi' grubs) to cover a number of different species. The early observations on the use of insects by Australian Aborigines were heavily biased because of the belief that their main source of food was animals hunted by men. The early non-Aboriginal observers were generally men, so their observations on the foods that Aboriginal women collected were generally limited. The collection of smaller animals (including insects) and plants by women was not, until more recently, well documented. The lack of information about insect foods could also be

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attributed to the European bias against insects and not considering them as a legitimate ‘food’ (Thomson 1982). Most observations were made by people without an entomological background − insects figure more prominently in reports on Aboriginal foods or culture by observers with some entomological background (Tindale 1953, 1972, 1981). The published observations on the use of insects as food by Australian Aborigines are confused because of inaccurate identifications, the failure to retain reference voucher specimens, the state of insect taxonomy in Australia (many species are still undescribed) and the diversity of Aboriginal languages and problems associated with recording and interpreting them (Yen 2012).

There was also a belief that Australian Aborigines lived a hunter gatherer life style and did not cultivate or store any food. This is not true, although the ways they cultivated foods were very different to cultivation in much of the rest of the world (crops and herd animals).

The Australian continent

Geologically, Australia is one of the oldest continents. It is one of the most recently settled continents, with Aboriginal colonization estimated to around 50 000 YBP[2] (Clarke 2003). It has undergone large physical and climatic changes, including the draining of a large inland sea, land connections to adjacent islands in times of glaciations and increasing aridity. It has nutrient-poor soils, extremely unpredictable and variable rainfall, and in parts, an environment that is shaped by fire. After settlement, the Aborigines were able to survive via hunter-gathering over much of the country. When Europeans settled in Australia over 200 years ago, they imposed European seasons and food systems; some European food systems have been successful while others have had disastrous consequences for the environment. More recently, people are recognizing that the Aborigines had their own seasonal calendars, most of which had many more seasons than the traditional four European seasons; furthermore, as Australia is a geographically diverse continent, these calendars varied across the continent (Clarke 2007; Prober *et al.* 2011).

Insects and other invertebrates used as food by Australian aborigines

The diverse variations in the Australian environment saw large regional and seasonal differences in food supplies and in how they were exploited (O’Dea 1991; Laudine 2009). Different proportions of food types (plants, vertebrates, fish, insects, molluscs and crustacea) were used in different regions. In the arid region, plants, mammals, reptiles and insects were the main foods. The inland temperate regions saw exploitation of plants, mammals, birds, reptiles, freshwater fish, molluscs, crustaceans and insects. In coastal temperate and coastal subtropical regions, marine vertebrates and invertebrates were an important additional resource, although there seemed to be a higher reliance on shellfish in Tasmania (Plomley 1977). Marine-based protein (fish and mussels) could provide 50 percent of the protein requirement of some coastal-based Aborigines (Hobson and Collier 1984).

Australian Aborigines were classed as primitive by early European settlers because they did not practise agriculture in a traditional European sense. Much of Australia is not suited for traditional European agriculture because of poor soils and unpredictable rainfall and the establishment of these systems has only been possible with massive fertilizer input and irrigation. This has resulted in long-term environmental damage such as habitat destruction, soil erosion and invasion by exotic plants and animals. However, there are more examples emerging about semi-domestication of plants and animals by Aborigines (Clarke 2003, 2007). Although the Aborigines were seen as hunter-gatherers who sought

[2] Years Before Present.

food on a daily basis, there is increasing evidence that they managed their environment to ensure sustainable food production, that they also stored some foods, and in some cases, that they farmed aquatic resources such as eels (Builth *et al.* 2008).

With traditional foods, it must be emphasized that insects and other invertebrates are only one component. Calaby (1971) suggested that insects are only utilized in times of food shortage.However, the importance of insects and other invertebrates has probably been underestimated and it is important that we try to ascertain which types of insects and other invertebrates were eaten. While the emphasis has been on insects, the non-marine and marine molluscs and crustaceans are also important; there is more historical evidence available about their use through the study of shell middens.

The insects used as food by Australian Aborigines are mainly the larvae of beetles and moths, honey ants, adult Bogong moths and insect products such as honey, galls and the sugary secretions of insects such as psyllids (lerps) and to a lesser extent, termites, scale insects, cicadas, grasshoppers, locusts and ant larvae (Yen 2005).

Insect larvae of many species were eaten. Many were identified simply as 'grubs' (e.g. Dawson 1881), or called witjuti (also spelt witchetty) or bardi grubs without reference to the correct use of these names (Yen 2005). The Aborigines often gave edible grubs names that indicated the plant species that they fed on (Yen *et al.* 1997). Many of these edible grubs are known only from local Aboriginal names (Meggitt 1962; Hercus 1989; Latz 1995) and there are numerous species from across Australia (Yen 2005), most of which cannot be named scientifically because they may be undescribed species or they have not been correlated with adults of described species (Yen 2012). There are records of grubs that are processed and stored for later use. Roth (1897) reported that larger grubs found in trees had their heads removed and were roasted or dried in the sun for future use. Green caterpillars (*muluru*) found feeding on 'grasses' in Central Australia were collected in large numbers; their heads were pulled off, the body contents emptied by squeezing and then dried in hot ashes, and either eaten or stored dry. The dried caterpillars were pounded with stones and kneaded into a paste and baked on coals when required (Chewings 1936; Kimber 1984; Hercus 1989). The Ayeparenye caterpillar is a very important ancestral being for the Arrernte people of Alice Springs. It feeds on the tar vine (*Boerhavis* spp.) and was collected in large numbers and gutted and cooked in hot ash; it can also be stored but not during rainy periods (Central Land Council 2007). Some Aborigines cultivated edible grubs by deliberately knocking off the tops of grass trees (*Xanthorrhoea*) to promote decay that increased breeding of bardi grubs (the cerambycid beetle *Bardistus cibarius*); 50 to 100 grubs could be found in a tree (Campbell 1965; Meagher 1974).

Most moths are consumed in their larval stages. In a few species the adults are consumed, and the Bogong moth (*Agrotis infusa*) is one of them. The larvae feed on lowland plants during the cooler seasons, and there is now evidence that Aborigines consumed them. The adults migrate to spend the hot summers in the cooler alpine region of southeastern Australia. Aboriginal men collected, tossed and roasted them to remove the wings, legs and heads, and they were either consumed immediately or pounded into a cake for later use (Flood 1980). There is some debate on whether women and children ate Bogong moths (Flood 1980; Bowdler 1981), and it has been suggested that the moths were of greater cultural than dietary significance. Many different Aboriginal groups came together over summer to feast on Bogong moths, and the men participated in ceremonies. Bogong moths may not have always been a reliable and vast source of food because their arrival time varied and sometimes strong winds blew them away from the Australian Alps into the sea (Flood 1980; Bowdler 1981).

Lerps are sugary secretions of sap-sucking insects known as psyllids found on eucalypt trees and were an important source of sweet food (Dawson 1881; Cleland 1957; Bin Salleh

1997). They were collected from the leaves by breaking off branches, dried for a few days, then shaken over bark or canvas. They were gathered and rolled into a ball that could be stored for months (Bin Salleh 1997; Central Land Council 2007). Psyllid numbers are often higher on the coppice eucalypt growth that regenerates after fire, and often lerp numbers are higher in the year following a fire. It has been suggested that Aboriginal firing of the land was undertaken to increase productivity, including lerp production (Yen 2005). Beveridge (1889) reported that an Aborigine could collect 20 kilograms of lerp (which he called Taarp) in a day, but this may be due to confusion with distinguishing lerps from plant exudates such as resins; Froggatt (1903) suggests that 1-1.5 kilograms/day is more likely. Aborigines maintained small-scale habitat mosaics of different fire ages that increased small-animal productivity (Bliege Bird *et al*. 2008). However not all of the land was burned due to heavier dependence on certain resources that would be lost if the land was burned too carelessly or intensely; for example, witjuti grubs depend upon certain wattles and if they are burned, the grub supply is lost (Cane 2002).

Shellfish were not considered an important food source by early European settlers because they were considered an indication of primitiveness or thought to be eaten only because of the unavailability of better foods (Meehan 1982), but their use was quite extensive based on records of shell middens (Frankel 1986; McNiven 1991; Nicholson and Cane 1991). Meehan (1977) found that shellfish were a main component of the diet of Anbara Aborigines on the north coast of Arnhem Land. There was seasonal variation in the exploitation of different habitats for shellfish. Women and girls were the principal gatherers, averaging 8.5 kilograms of shellfish per trip; while men and boys averaged 11 kilograms per trip, but they made fewer trips. Davies (1989) outlined the seasonal use of molluscs and crustaceans in Arnhem Land and showed that different species were utilized at different times of the year. There is a reference to storage where a cache of freshwater mussels was found buried in deep moist sand (Simpson and Blackwood 1973). One marine creature that is reputed to have been cultivated is the cobra grub or shipworm. It is neither an insect nor a worm but actually a bivalve mollusc (*Teredo* sp.) (Attenbrow 2009). Aborigines put old logs into saltwater to increase numbers of this shellfish (Campbell 1965).

Importance of myth and ritual in food sustainability

Communication

Aboriginal languages involved passing on information orally and the use of artwork and carvings. Aborigines do not see themselves as having colonized Australia; they believe that their mythological ancestors (spirit beings) arose out of the land, and Aborigines are part of the land (Clarke 2003). They have myths that follow the trails (Dream paths) of the spirit beings in the Dreaming; the trails join important geographic and economic locations and they can be likened to a survival map because these spirit beings are responsible for creating and sustaining land fertility (Berndt 1972; Laudine 2009). With regard to individual foods, there can be songs about when they are more likely to occur; Tindale (1953) states that at least three groups (Ngalia, Pitjantjatjara and Pintubi) have ceremonies concerning edible grubs.

Food rituals, totems and increase ceremonies

Food procurement did not involve random hunting and gathering. Food had important cultural values (Thomson 1982; Palmer 1999; Rigby 2011) and there were ritual requirements regarding who could collect certain foods, who could eat them and when they could eat them (Spencer 1914; Kaberry 1938). Each traditional Aborigine belongs to a totem group. Many totems have food value (Strehlow 1965; Walsh 1990) and there are sometimes rules that prevent an individual eating his or her own totem or permit them to be eaten only at certain times. It is thought that this type of ban teaches individual responsibility and encourages group responsibilities (you rely on other totems for food) (Laudine 2009). The role of myth in edible insects is well illustrated by Strehlow (1970) with regard to the honey ant. In Central Australia, the original honey ant ancestors travelled along a 600-kilometre route that had totemic centres along the path. Honey ant verses were sung at each of these centres and the relevant honey ant groups had to stage the complete ceremonial cycle associated with their centre. The complete performance cycle may have been performed every 15 to 20 years, but the members of each honey ant clan had to attend honey ant cycles of adjacent honey ant centres.

Increase ceremonies are often thought to be about food, but there are increase ceremonies for non-food plants and animals, so their purpose may be more for maintenance of the normal order of nature (Kaberry 1938; Laudine 2009). Spencer and Gillen (1899) described a major increase ceremony for the witjuti grub at Emily Gap (near Alice Springs); however the actual edible species there are not witjuti grubs but other species of caterpillars and it is possible that the importance of the increase ceremony is to enable neighbouring groups to meet and trade (Morton 1987).

In Central Australia, Aborigines view law and ceremony as essential to maintaining the land. Older people have the knowledge about the law and see it as their role to teach successive generations about it through ceremonies, songs, dances and stories (Brown and Haworth 1997). The law regulates use of natural resources by protecting areas of biological importance (sacred sites) and also aspects of hunting and food distribution through totems and taboos aimed at perpetuating all extant species. For example, while ceremonies were important for increasing resources, resources were also protected by taboos. The Arrernte in Central Australia did not permit hunting or gathering in some very high quality areas (which usually have permanent water) (Strehlow in Berndt and Berndt 1965). Newsome (1980) found a ban on the hunting of red kangaroos near its totemic site; this area was also the best habitat for this species.

Aboriginal health issues

Pre-European settlement

Aboriginal societies did not view health the same way as Europeans and linked together personal, social and environmental well-being as elements of health (Healthy Aboriginal Life Team 1991). Consequently, good health meant a good supply of food from a land that resulted through the actions of the ancestral spirit beings. A healthy diet involved active hunting and gathering; for example, in the Kimberley Region (northwestern Australia), a healthy diet comprised wild cat (an introduced species), dingo, cockatoo, flying fox, echidna, snake, turtle, duck, freshwater crayfish, ant eggs, brown ants, manna, caterpillars, insect galls, sand frogs, bush honey, tree gum, goanna, fish, mussels, witjuti grubs, grasshoppers, bush turkey, emu, emu eggs, pigeon and crocodile (Kouris-Blazos and Wahlqvist 2000). This was a diverse diet, and insects figured prominently in it.

With regard to insects, Tindale (1953) noted the importance of insects for healthy babies. An overlooked factor in hunter-gatherer societies is the problem of weaning children in the total absence of sources of milk other than the mother. The most important supplementary food is the larvae of wood-boring and root-feeding cossid moths, hepialid larvae, buprestid and other large beetle grubs, all rich in fats. Some weigh up to 30 grams or more, and take on greater nutritional importance in terms of short-term drought because they have a life cycle that lasts two to three years (Tindale 1981). The absence of such supplemental foods led to malnutrition among children and a form of scurvy among adults (Tindale 1981).

Post European settlement

The adoption of western lifestyles has seen less use of wild foods by Aborigines, although they are still preferred. This is a problem across the Asia-Pacific region, where people are offered abundant refined and fatty food supply (especially sugar, fatty beef and white flour) that lead to obesity, cardiovascular disease, diabetes, certain cancers, osteoporosis and immune deficiency which can be compounded by a more sedentary lifestyle and overuse of alcohol (O'Dea 1991; Wahlqvist *et al.* 1991; Wahlqvist 1995).

Adoption of some traditional foods is encouraged for health reasons because some native foods are more nutritionally beneficial than introduced foods (Cherikoff and Brand 1983). The value of Aboriginal food plants, with their low carbohydrate levels, high dietary fibre content and their provision of important dietary components, is often overlooked (Brand-Miller and Holt 1998; Leemon and Samman 1998; McArthur *et a l.* 2000). There are studies showing that Aborigines living on traditional foods had better health than those on a settlement diet (flour-sugar-tobacco-tea); changing from a settlement to a traditional diet, and its associated lifestyle change involved in getting these foods, improved health considerably with lower risk of diabetes, high blood pressure and heart attack (Milburn 2004; Wahlqvist and Specht 1998). Salem *et al.* (n.d.) give guidelines to nutritional values of traditional foods ('bush tucker') to reduce the risk of diabetes and kidney failure among Aborigines.

The importance of traditional diets and personal health is illustrated in the book *Anangu way* (Healthy Aboriginal Life Team 1991) for which members of Pitjantjatjara communities in Central Australia prepared over 50 paintings about their way of life and health and social issues associated with their communities. About half of the paintings refer to traditional foods: they are seen as healthy foods and important in maintaining social order in the communities. About 20 percent of the paintings involve witjuti grubs and honey ants. The theme of this book is the importance of traditional foods in maintaining health and the problems associated with introduced foods; insects certainly figure prominently in this diet. Traditional diets rely on biodiversity providing a varied food supply and a diverse food supply protects against climatic and other disasters that can act against use of a few food types. The conservation of biodiversity results in environmental stability as well as spiritual well-being (Wahlqvist and Specht 1998).

Future directions and requirements

Opportunities

While this discussion is primarily about Australia, the same issues confront the remaining Oceanic nations as well as many other parts of the world. There is now a considerable body of information indicating that insects can be an important source of human food, involve less environmental problems in their production and can be integrated in the feed of livestock (Yen 2009). There is a risk that global acceptance of insects as food could involve utilizing a small number of species, thus falling into the trap of relying on a small gene pool with its inherent problems associated with other foods. Insects are one of the most biodiverse groups of animals, and utilization of this natural diversity is an opportunity to avoid genetic bottlenecks and to employ the invaluable knowledge of traditional peoples across the world.

There are important long-term benefits in exploiting endemic Australian insect species as food or feed. These include: (1) conservation of Australian natural biodiversity and its environments; (2) the opportunity to document our natural resources; (3) greater opportunities to manage the land for long-term sustainability (in conjunction with Aboriginal elders); and (4) opportunities to find new food resources (including medicines). There will also be chances to: (1) acknowledge traditional Aboriginal culture; (2) prevent further loss of traditional knowledge and hand on the information to future generations of Aborigines; (3) improve the health of Aborigines; (4) develop a national identity involving indigenous Australian foods (Santich 2011); and (5) establish small-scale commercial industries for Aboriginal communities through semi-domestication of edible insects (Yen 2010).

Issues

Identification of edible insects

The Food and Agriculture Organization of the United Nations has recognized the need for nutritional indicators for biodiversity to provide a link between biodiversity, food and nutrition and the need to enhance sustainable use of food biodiversity to combat hunger and malnutrition (FAO 2008, 2010). The first step involves developing a list of underutilized species that includes: (1) identities of the food (scientific names at the species level and, if relevant, below); (2) local names; and (3) related digital images, DNA fingerprinting and/or vouchers. In Australia (and elsewhere), there is a need for a national database of edible insect species that includes regional local names, images and information on how they are obtained and used (Yen 2012). Naming edible insects can be difficult because sometimes it is the immature stages that are utilized (and taxonomy is based on adult stages) and the species may still be undescribed.

Loss of and changes to traditional knowledge

Knowledge about edible insects is now more likely to be in the hands of more elderly members of communities, and we are facing a situation where knowledge could be quickly lost. It is imperative that this information be documented, allowing for possible sacred cultural information, and also recognizing the intellectual property rights of traditional peoples; for example the development of native *Acacia* plants as food is based largely on Aboriginal knowledge (Devitt 1992).

Acknowledgement is needed that traditional knowledge is not static and that it can change, sometimes rapidly. McNiven (1991) found a sudden increase in shell middens in coastal southeastern Queensland after European settlement, suggesting that that pastoral and forestry industries drove Aborigines to the poorer grazing areas by the coast. Some Aboriginal groups ate abalone, but this now conflicts with the very profitable commercial trade to Asia. While Aborigines consumed shellfish in the past, use has declined considerably; however, shellfish gathering has been taken up by several Asian immigrant groups and shellfish have been overharvested in some locations. An understanding of Aboriginal harvesting regimes may assist in developing protocols for sustainable harvesting in the future.

Sustainability

If the use of traditional foods is to be encouraged for environmental, health and cultural reasons, there is the danger that greater utilization of wild foods may result in sustainability issues. Aboriginal communities could derive additional income by the collection of edible insects for the tourist and restaurant industries (Bruneteau 1996;

Santich 2011) and there is the danger that they may forego their own use in preference for cash income. Overcollecting could involve gathering more specimens than traditionally practised, collecting over a wider region, harvesting beyond the usual season, using modern technology that results in more efficient collection and even gathering in sacred sites. If wild harvesting is the main mode of production, then it is essential that a partnership is established to integrate traditional knowledge about the target species and western conservation biology in order to ensure sustainability.

Semi-domestication

One alternative is to consider semi-domestication of edible insects. This could take the form of environmental manipulation to increase populations (such as the use of fire to stimulate plant growth or the damaging of grass trees to increase bardi grub numbers), or some form of mass captive breeding. Research is needed to determine the technical feasibility of the latter. For example, there has been preliminary work on rearing of cossid moth larvae in captivity and it may be possible to establish systems to rear moth larvae that feed on tree roots or in tree trunks (Rich 2006). On the other hand, an insect like the honey ant could be very difficult to breed in captivity because the system involves the honey ant, mulga trees and scale insects that feed on these trees. In order for local communities to benefit, any attempts to semi-domesticate edible insects must have local Aboriginal community ownership, but may also require scientific assistance to develop techniques that are suitable for remote communities with relatively little infrastructure (Whitehead *et al.* 2006). There will have to be serious consideration of the markets, selection of target species (involving both Aborigines and external scientific advice), determination of cultural appropriateness of commercial harvesting, the environmental effects of such activities and the potential to add value to the product (Whitehead *et al.* 2006). The latter could involve marketing that involves insect products, stories about them and art work.

There have been projects involving traditional plant foods such as the Desert raisin (Katyerr or Bush tomato) which is harvested by Aborigines and marketed commercially; there is the danger that increased demand may dilute the Aboriginal customary harvesting protocols such as the use of seasonal fire to encourage plant growth (Holcombe *et al.* 2011). Brown and Haworth (1997) found that the collection of native plants and animals by the Walpiri people in the Tanami Desert still maintained many of their traditional beliefs and ceremonies, which include sanctions against overharvesting. They suggest that the establishment of a bush tucker industry adapting traditional land management techniques could be better for sustainable land management as well as maintaining indigenous culture. Another example involves truffles. The Aborigines of Central Australia have traditionally used desert truffles as food. Truffle hunting in the desert requires substantial ecological knowledge and they are generally collected by women. The truffles are eaten raw or baked or roasted in ashes. Seven truffle species have been recorded from the Australian Outback, including three that have been described only recently (Trappe *et al.* 2008).

Oceania

Other Oceanic nations and some Asian nations face the same loss of traditional knowledge as they become more ‘developed’ and commercial pressures increase to use these foods. Bodenheimer (1951) had very little information about edible insects in Oceania except for Australia. DeFoliart (n.d.) lists the edible species from the area, and except for Papua New Guinea (including West Papua), there is very little information about their use in the rest of the region.

Edible insects in West Papua have been considered by Tommaseo-Ponzetta and Paoletti (1997), Schiefenhovel and Blum (2007) and Ramandey and van Mastrigt (2010), and in Papua New Guinea by Meyer-Rochow (1973), while their contribution to the total diet is discussed by Dwyer (1985a,b) and Dwyer and Minnegal (1991). Meyer-Rochow (1973) discussed insects eaten by three ethnic groups in Papua New Guinea, the Kiriwina (Trobriand Islands), Chuave (Central Highlands) and the Onabasulu (Southern Highlands), and this illustrates the great diversity of different ethnic groups there. The most widely eaten insect is the sago weevil, *Rhynchophorus ferrugineus papuanus* (Mercer 1977), which is farmed by felling mature sago palms and removing squares of cortex for adults to lay their eggs.

Very little is known about the use of insects in the Indonesian islands west of the Wallace Line. It is generally assumed that Muslim Indonesians do not eat insects, although Edwards (1998) lists insects eaten in Central Java. While Java is west of the Wallace Line, it is likely that the Melanesian people on the eastern Indonesian islands use insects as food. Grasshoppers are consumed by people in East Timor (P. Sturgeon, Australian Plague Locust Commission, personal communication 2009).

Pond (1994) listed a few insects eaten in Oceania. This is not practised much now and Pond laments the loss of knowledge about insects, which is now primarily only known by the elderly. Pond (1994) provides photos of traditional insect storage utensils and mentions the use of the larvae of the cerambycid beetle, *Oleuthrius villosus*, as food in Tonga and Samoa (known as the Afato grub), Fiji (Yavato), Futuna ('afato) and Rennell (Ahato). Huhu grubs (or Tunga) (the cerambycid beetle, *Prionoplus reticularis*) were eaten in New Zealand, but less so in the north where there were more marine resources. *Placostylus* is a genus of land snails found in the Solomon Islands, Vanuatu, New Caledonia, Fiji, Lord Howe Island and New Zealand. In New Zealand, Hayward and Brook (1981) considered *Placostylus* as only a minor occasional food source for prehistoric Maoris, although they suggest that they did transfer *Placostylus* to offshore islands where marine shellfish were not abundant. The transfer could have been deliberate to supplement local food resources or an accidental escape of live snails taken over as food. On the other hand, Bresica *et al.* (2008) believe that *Placostylus* is threatened by overcollection for human consumption in Melanesia. It is a traditional food on the Isle of Pines where boiled snails are still eaten and represent an important source of protein. *Placostylus fibratus* became a delicacy in Nouméa around 1950. Snail-harvesting for consumption from the natural populations on the Isle of Pines progressively increased and reached 48 tonnes (about 700 000 snails) in 1993 and the export of the snails became an important economic activity for 70 families. The export to Nouméan restaurants and supermarkets from the Isle of Pines was prohibited in 2000 to reduce the number harvested. A survey conducted from 1995 to 2004 estimated that the total population of *P. fibratus* on the Isle of Pines was between 4 to 5 million and that the population was stable. Harvesting from the natural populations for local use since 2003 is estimated now to be around 120 000 adult *P. fibratus* per year. The conservation status of *Placostylus* has seen research undertaken on the feasibility of captive breeding (Bresica *et al.* 2008; Stringer and Grant 2007), so there is potential to semi-domesticate them.

Conclusions

The nutritional importance of insects as food among Australian Aborigines is still a matter that requires further investigation. There is no doubt that the range of foods utilized by Aborigines was diverse and varied considerably, both geographically and seasonally. Insects were probably more important in the semi-arid, arid and temperate regions of Australia. One fact that cannot be disputed is that there is a preference for traditional foods and that they result in better health. However Aboriginal societies have a very close relationship to their lands and the linkages between environmental management, healthy food, traditional knowledge, ceremonies and art are very strong. The issues in Australia are just as relevant and important in the adjacent nations in Oceania.

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Edible insects and local livelihoods in Japan

Kenichi Nonaka[1]

Insects are both bio- and cultural resources that can reflect rich biodiversity. They are eaten in many parts of the world, including Japan. This study aims to clarify the interrelationship of collecting and eating insects in Japan and local socio-cultural and environmental characteristics. It focuses on the traditional use of edible insects in local livelihood systems, exploring some of the diverse relationships between humans and insects. The characteristics of insect use in relation to rice cultivation and other related subsistence activities as well as their commercial value are discussed. Data are based on the author's fieldwork in many parts of Japan since 1985 with emphasis on collection, cooking and marketing of insects and their social roles.

Keywords: Edible insects, local livelihoods, cultural practices, Japan

Edible insect diversity

Food insects are sometimes described as food for the poor. In reality, most people eat them because they are highly palatable and enjoy the process of collecting them.

Insects are important natural resources in terms of supplementing diets and as commercial food products in many parts of the world (Bodenheimer 1951; Mitsuhashi 1984; Nonaka 2005). Globally, more than 1 900 species are regarded as edible (Mitsuhashi 2009). Consumption of insects is considered important historically as an original source of animal-derived proteins and fats.

The use of insects as food is highly diverse worldwide from temperate to tropical zones. Although quite rare in Western countries and those regions influenced by the Islamic faith, the eating of insects is widespread in Asia, Africa and Oceania. In China, one finds dishes containing all manner of insects on ancient imperial menus; in Southeast Asian countries such as Thailand, Lao PDR and Viet Nam, a variety of insects are cooked and sold in markets as popular meals. Globally speaking, insects are by no means rare or unusual food sources.

In Japan 55 species were recoded as edible in a report 90 years ago (Miyake 1919). These numbers have declined but insects are still eaten nationwide (Figure 1). Grasshoppers, wasps, silkworms, long-horned beetle and aquatic larvae are popular in many places.

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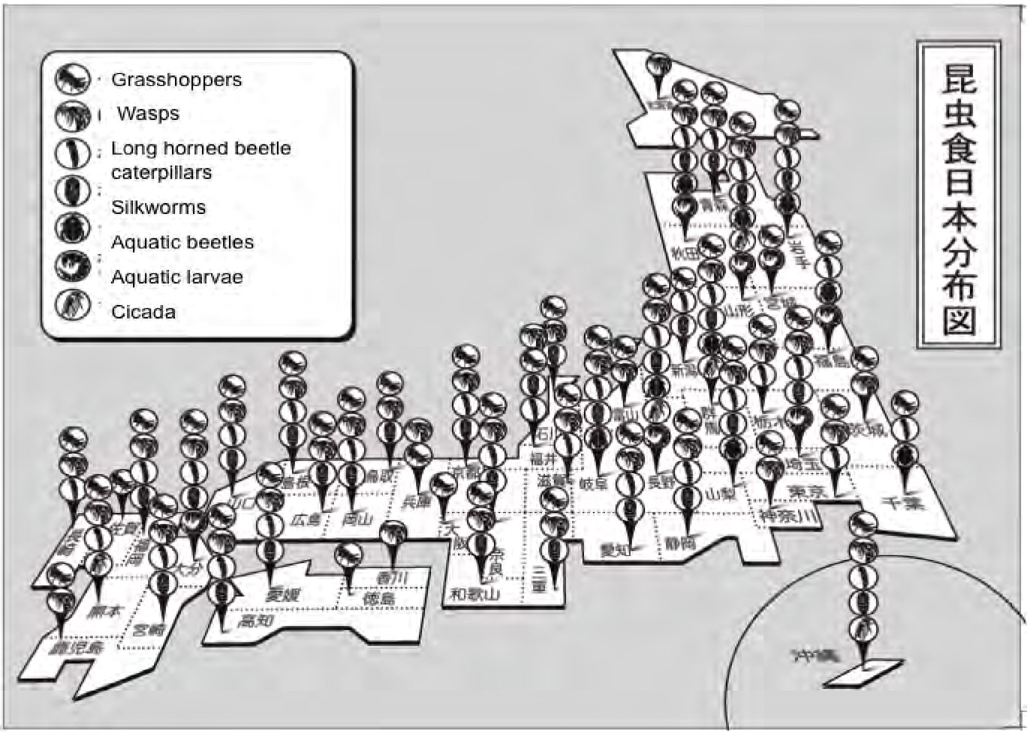

Figure 1. Regional distribution of edible insects in Japan (Nonaka 2009)

Grasshoppers (mainly *Oxya yezoensis*) are eaten widely in Japan. The insects are sold after being cooked (boiled) in soy sauce. Rice grasshoppers can be collected from paddy fields early in the morning, as it is easy to collect them while the ground is wet with morning dew (Figure 2). Some people devote themselves to day-long collection for a greater harvest.

Figure 2. Collecting grasshoppers (courtesy Kenichi Nonaka)

Grasshoppers are usually kept alive for one night after collection in order to remove dung completely. Some people in Tohoku area do not like to remove it. The next day, they are fried or boiled. Then the legs are removed as they are not edible. After sun-drying, they are cooked in soy sauce and sugar. They are eaten as a side dish or *otumami* in the autumn. Some people store and eat them throughout the year.

In special shops which sell domestic grasshoppers, many people come to buy them early in the morning. However local populations are declining in Japan and considerable quantities are imported from other countries.

They are sold as souvenirs as well (for example at the famous Narita Temple in Chiba Prefecture, close to Tokyo, Figure 3). They are cooked as *tsukudani* (i.e. boiled in soy sauce and sugar) and sold in shops. Visitors buy them as souvenirs after praying at the temple.

Figure 3. Cooked grasshoppers on sale at Narita Temple (courtesy Kenichi Nonaka)

The pupae of the silkworm (*Bombyx mori*) are also cooked in soy sauce and eaten. When the silk industry was active, pupae were used after removing silk from the cocoons, although much of the by-product was wasted. They were brought to a food company or sold to neighbouring silk factories. The packed food (for side-dishes as well as snacks) is still sold at food stores in Nagano Prefecture in central Japan (Figure 4).

Figure 4. Edible silkworms (courtesy Kenichi Nonaka)

In Japan more than 40 years ago, when fuelwood and charcoal were still used for cooking, people in mountainous areas ate long-horned beetle larvae (Cerambycidae) found in woods. The larvae are easily collected from trees when they are cut. The author has heard many old men reminiscing about the larvae's sweet, delicious taste and has eaten them himself with great pleasure (Figure 5).

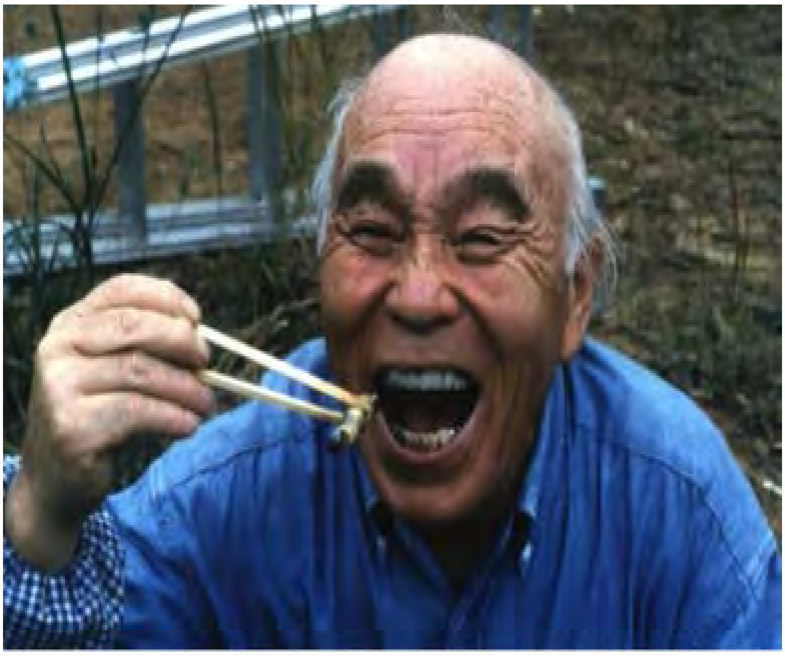

Figure 5. Eating long-horned beetle larvae (courtesy Kenichi Nonaka)

Wasps are popular food items in mountainous Japan. Yellow jackets (*Vespula* spp.) in particular are eaten in many areas. Wasp-eating in Japan, for example, illustrates how people enjoy both collecting and eating yellow jacket wasps as part of their culture. Their nests are found below ground in fields and mountains, making it rather difficult to locate them. Locals have devised a uniquely ingenious way to locate the nests (Figure 6).

Bait is used to attract the worker wasps. The wasps are then given small pieces of meat, with tiny ribbons attached, to carry back to the nest. The ribbons make it easier to subsequently follow the wasps and locate the nest. Following the workers back to the nest requires teamwork − someone is needed to set the bait, someone to follow the wasps and someone to dig out the nest and sedate the wasps inside with smoke.

Figure 6. Collecting yellow jackets (courtesy Kenichi Nonaka)

Some people dare to collect *Vespa* spp., especially *Vespa m andarinia*, which is more dangerous because of its strong attack and poison. But it is bigger and just as delicious. Skilled techniques are needed to protect against attacks and a special protective suit has been developed for approaching the nest.

Some people even raise yellow jackets at the bottom of their gardens or in special hives (Figure 7). They are careful to place the nest where it will be sheltered from the elements. The wasps are protected from predators and given food. Rearing yellow jacket requires a certain combination of care, originality and ingenuity.

Figure 7. Rearing yellow jackets (courtesy Kenichi Nonaka)

Yellow jackets have great commercial value as well as being a cultural resource asset (Nonaka 2010). Raw nests with larvae and pupae are sold at the market (Figure 8). Canned yellow jackets as well as locusts are also sold in Japan. They are expensive, but people like to buy them. They are also imported from China, Republic of Korea and New Zealand.

Figure 8. Yellow jackets on sale at the market (courtesy Kenichi Nonaka)

Recipes for wasp dishes vary greatly from household to household but usually bring an autumn feast to the dinner table (Figure 9). They also provide an ideal accompaniment for *sake* (rice wine). Food products made from wasp are popular delicacies and make great souvenirs.

Preparation of wasp dishes takes much time and effort, but this provides an opportunity for the family to enjoy socializing.

Figure 9. Yellow jacket cuisine (courtesy Kenichi Nonaka)

The Yellow Jacket Festival is held every year, with people competing for the biggest nest in about 20 communities in rural central Japan. The nests are raised at home, or collected from fields and mountains. People gather for all manner of festivities to celebrate them even if they may get stung.

Cicadas, aquatic insects such as diving beetles and water scavengers have been eaten in Japan but not on a large scale. The larvae of caddis flies (Trichoptera) and stonefly (Plecoptera) are still collected and eaten in the upper part of Tenryu River in Nagano Prefecture (Figure 10).

Figure 10. Aquatic insect larvae (courtesy Kenichi Nonaka)

The consumption of edible insects has established various techniques for collecting and cooking a large variety of insect species, reflecting regional preferences, with a long tradition of socio-cultural significance. The use of insects is part of subsistence and daily life, relating people to the natural environment. As people can collect insects easily a close relationship and familiarity with them has been developed. This exemplifies the bond between humans and nature.

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Porcupine breeding in Viet Nam

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Porcupines occupy a wide range of habitats in tropical and temperate regions. As part of FAO's Participatory Watershed Management Project in Hoanh Bo District in 2003 they were successfully introduced to the villages of Dong Lam, Tan Dan and Dong Son in Hoanh Bo District of Viet Nam as a source of protein. They are also used in traditional medicinal treatments. Porcupine breeding gives good financial/economic results. Many families earn high revenue from breeding and selling porcupines.

Keywords: Porcupines, protein source, traditional medicine, Viet Nam

Background

In early 2003, the Participatory Watershed Management Project in Hoanh Bo District carried out by the Food and Agriculture Organization of the United Nations successfully introduced 64 porcupines (*Acanthion subcristatum*) from Son La Province in Viet Nam to the villages of Dong Lam, Tan Dan and Dong Son in Hoanh Bo District. Within one year the porcupines had adapted to the local climate and started to reproduce.

Although the project closed at the end of 2003, the Hoanh Bo District authorities acknowledged the success of this FAO pilot demonstration and provided financial assistance to more families in other villages to introduce another 100 porcupines.

At the end of 2011, there were 2 297 porcupines in Hoanh Bo District (Table 1).

Table 1. Porcupine populations and breeding locations in Hoanh Bo District

Villages/towns	Number of families breeding porcupines	Number of porcupines
Thị trấn Trới	15	105
Kỳ Thượng	4	16
Đồng Sơn	35	302
Tân Dân	40	568
Đồng Lâm	25	295
Hoà Bình	8	58
Vũ Oai	6	39
Dân Chủ	10	143
Quảng La	24	210
Bằng Cả	10	52
Thống Nhất	20	288
Sơn Dương	18	126
Lê Lợi	10	95
Total	**225**	**2 297**

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Porcupine facts

Porcupines occupy a range of habitats in tropical and temperate zones. They can live in forests, deserts and hilly land. Porcupines are generally nocturnal but are occasionally active during the day.

Porcupines are large rodents with a thick coat of quills that defend and camouflage them from predators. Porcupines are the third largest rodent behind the capybara and the beaver. Most porcupines in Viet Nam are about 80 to 90 centimetres in length and weigh approximately 15 to 20 kilograms. The porcupine male is more aggressive than the female.

In captivity, porcupines can be highly familial creatures, but in the wild they are shy and retiring. The common porcupine is mainly herbivorous. It eats leaves, herbs, twigs and green plants like skunk cabbage and clover; in winter it may eat tree bark. They sometimes eat insects and worms. Reared mainly as a source of protein, some porcupine body parts are used in traditional medicine applications.

The captive porcupines in Viet Nam are fed with vegetables, fruits, mixed bran, rice, maize, beans and peanuts twice a day depending on their age.

Porcupines breed in the autumn and their young are born in the spring with soft quills which harden shortly after birth. Porcupines can reproduce at one year of age and pregnancy lasts for 90 to 95 days. They can produce two litters per year, with each litter comprising one to three individuals. They mate at night.

Rearing arrangements

Ensure a cool, dry, clean environment and position the shed in a southeasterly direction. The shed should be quiet and noise must be avoided (do not rear porcupines near roadsides). The average space needed is 1 square metre for each individual; stalls should be 1-1.5 metres wide, 1.5 metres in length and 1-1.2 metres in height. It is important to:

- Clean stalls daily;
- Prevent inbreeding;
- Ensure protection against disease;
- Maintain daily nutritional needs;
- Provide bitter-tasting fruits that porcupines like to consume to prevent digestive complaints

Socio-economic benefits

Hoanh Bo District, Quang Ninh Province now has about 200 households feeding a population of 2 297 porcupines. Households can earn VND18-25 million/year[2] from rearing a pair of the animals.

The typical investment required for a farmer to start raising porcupines is VND10-15 million per pair. But the farmers can keep two to three female porcupines with one male to save money. Operating costs (mostly for feed and simple care) are negligible as most of their dietary intake is planted by farmers.

[2] US$1.00 = VND20 844.80 (July 2012).

Farmers can sell one porcupine for VND20-25 million or VND350 00/kilogram. They are purchased by farmers who want to raise them, restaurants, porcupine-breeding projects, intermediaries, traditional medicine practitioners and for household consumption.

The original breeding stock came from Son La Province but is now supplemented by farmers from other locations; there is a large potential market in Halong Bay where thousands of tourists come every year, many of whom are Asian.

Conclusion

Porcupine breeding gives good financial returns. Many families earn high revenue from this activity. It is likely that an association of porcupine and other wild animal breeders will be established in Hoanh Bo District in the near future. Efforts should continue to encourage families to develop larger farms for this industry. Promotion of the activity could be accomplished via local media.

Edible tarantulas and crickets in Cambodia: informal markets and potential contribution to rural livelihoods

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Eating insects as part of the daily diet (entomophagy) is common in Southeast Asia. In Cambodia, most people regularly consume a variety of insects and spiders and an informal market for such food sources has developed throughout the country. This market contributes an additional source of income to rural/urban livelihoods.

In this study a market assessment was conducted in six provinces, including the capital Phnom Penh, as well as a review of the current institutional framework regarding policies and responsible stakeholders. Both qualitative and quantitative research methods were applied. The data were collected from January to May 2012. The study is part of the WINFOOD project, a collaboration between the University of Copenhagen and the Department of Post-Harvest Technologies and Qualitative Control, Fisheries Administration, Cambodia.

The findings show that crickets have the potential for a larger domestic market, as well as export to neighbouring countries, through domestication and scaled-up collection practices. On the other hand, edible tarantulas are facing the challenge of overexploitation due to increased market demand, which puts pressure on the natural population of the tarantulas and consequently, the livelihoods of collectors.

Among government and international agencies awareness of the potentials and constraints of the edible insect sector is limited. This is a field which is gaining more international recognition as an alternative source of food and livestock feed and therefore it is recommended that the Cambodian Government and other stakeholders begin investigating the potentials and limitations of the edible insect market.

Keywords: Alternative food sources, Cambodia, entomophagy, tarantulas, crickets, value chain

Rationale

This paper presents preliminary findings from a field survey conducted from January to May 2012 by the University of Copenhagen and the Fisheries Administration, Cambodia. The research is part of the WINFOOD project which is assessing the benefits of utilizing local foods to prevent child malnutrition.

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The objective of the research was to map out the value chain of the edible tarantula (*Haplopelma longipes*) and also to gather data on the informal market of crickets as a possible alternative due their wider availability in the region. Interviews were conducted in six provinces with stakeholders within the value chain and stakeholders of possible responsible national and international agencies.

Entomophagy in Cambodia

Research on entomophagy in Cambodia is currently still limited with only a few reports describing entomophagic practices among the Cambodian population or trade with other countries (Ratanachan 2009). Most information is published via popular channels such as books, travel blogs, newspaper articles (Meas 2012) and films, usually focusing on the edible tarantula and crickets.

The first data on the consumption of insects and other aquatic animals were compiled by the Baseline Assessment of Nutrition and Diet in Cambodia in 2011 (Touch Bunthang, personal communication February 2012); it was indicated that insects (and other arthropods such as tarantaulas) are commonly consumed in Cambodia.

Table 1. Species identified during the research (January to May 2012)

Cambodian name	Cambodian common name	English common name	Scientific name	Order/family
Aping	Edible spider	Tarantula	*Haplopelma longipes* (Wirth & Striffler)	Araneae/ Theraphosidae
Kmol	Mud cricket	Mole cricket	*Gryllotalpa africana* (Beauvois)	Orthopetra/ Gryllotalpidae
Chang Rit Dek	Black cricket	Two-spotted cricket	*Gryllus bimaculatus* (De Geer)	Orthopetra/ Grylliadae
Chang Rit Krohoam	Red cricket	Field cricket	*Acheta testacea* (Walker)	Orthopetra/ Grylliadae
Chang Rit Doung	Coconut cricket	Short-tailed cricket	*Brachytrupes portentosus* (Lichtenstein)	Orthopetra/ Grylliadae
Kantes Lang	Water beetle	Water beetle	*Cybister limbatus* (Fabricius)	Coleoptera/ Dytiscidae

Source: Ratanchan (2009).

Edible spiders in Cambodia

As a ‘specialty’ Cambodian markets feature the edible tarantula (*Haplopelma longipes*) as a food item. This has been highlighted by national and international media in books (Menzel and D’Alusio 1998), newspaper articles (Meas 2012) and films.

The most prominent centre for trade is the town of Skun in Kampong Cham Province where spiders are sold deep-fried as a roadside snack. However increasing demand and conversion of tarantula habitats to mango, cashew nut plantation, have led to a decrease in local harvest. Traders now source the spider from other provinces in the northeast and west of Cambodia, namely, Sieam Reap, Kampong Thom, Preah Vihear and Kampong Cham.

During the field study, villagers from Pursat and Battambang also reported spider consumption but no trade was carried out as collection was solely for household use.

Villagers in the visited villages reported that they collected tarantulas by digging them out of their tunnels. Through local intermediaries villagers can sell tarantulas for 200 to 300 riels per piece (US$1.00 = 4 050 riels). The intermediaries are in charge of their transport mainly to Skoun and Phnom Penh via regional traders. Street prices for deep-fried tarantulas are 1 500 riels per piece and up to 10 000 riels for live spiders. Tarantula trading mainly occurs on the domestic market with limited export to neighbouring countries, mainly as an ingredient in rice wine.

According to villagers, increasing collection in the wild and land-use change through conversion of forest and shrubland are decreasing the spider populations around their villages. Villagers are aware of this change, but the income from spider sales contributes to their household income, especially in the dry season.

From a nutritional viewpoint, tarantulas have a very high content of zinc (40-50 mg/100 grams dry weight). Zinc is an essential mineral for child growth and is often limited in diets in developing countries. On an experimental basis, tarantulas have been added to complementary food ('babyfood') and the nutritional impacts were assessed in a human intervention study conducted under the WINFOOD project in Cambodia. Results will be available in 2012.

a

b

Figure 1. (a) Roasting tarantula; (b) tarantula with local wild plants (courtesy C. Münke)

During the field research villagers shared a variety of recipes on how they incorporate the spider into their diet:

- Fried in oil with seasoning (e.g. chilli, salt, pepper, sugar, MSG);
- Roasted over fire;
- Fermented with local leaves and roots.

The tarantula is mainly eaten as a side dish in rural areas next to rice. In Phnom Penh the spider is also served in restaurants as an appetizer.

The market for crickets in Cambodia

The Cambodian market for crickets currently focuses on four species which are sold within the country and also exported to Thailand and Viet Nam, Thailand being the main market.

The main centre for collection is around Tonle Sap Lake in the provinces of Kampong Cham, Kampong Thom, Sieam Reap, Pursat and Battambang, where villagers along National Roads 5 and 6 have installed light traps to attract crickets at night. Collection occurs near national roads due to easier transport, the vast plains of surrounding rice fields and the availability of electricity for the traps. Frequency, scale and skill in catching crickets however differ in each province. The traps also attract other insects which are not sold on the market and are used as chicken feed or composted.

The scale of trapping varies with the season and is mainly carried out between November and May, the dry season in Cambodia. The effect on biodiversity is yet unknown with respect to potential benefit as a pest control measure (Yen 2009).

Households that collect crickets with traps also supplement their diet with crickets. Families use species that cannot be sold as chicken food. During interviews villagers stated that their consumption increased with the availability of cricket traps, compared to earlier occasional wild collection of larger crickets. Older villagers in different provinces indicated that crickets were also eaten in the time before the Khmer Rouge regime, with a focus on larger crickets. The nutritional contents of several species have been identified (Yhoung-Aree and Viwatpanich 2005); data on traditional preparation methods and their nutritional content are not available but could show beneficial results similar to findings in Lao PDR (Nurhasan *et al.* 2008).

The main cooking method for crickets is deep-frying in oil and seasoning with spices. During the research villagers preferred this method as the cricket could be eaten as a snack or as a supplement to rice and other dishes.


a

b

Figure 2. (a) Mixed crickets ; (b) cricket-mango salad (courtesy C. Münke)

In different provinces in Cambodia, farmers have started cricket farms mainly with two-spotted crickets (*Gryllus bimaculatus*) and ground crickets (*Acheta testacea*). Production is for the domestic as well as export market. There is an informal network among some of the farmers to exchange information and cricket eggs. The motivation for engagement in cricket farming is mainly to earn extra income as demand over the last few years for crickets has increased. Knowledge about farming activities and operational set up mainly comes from Thailand or through exchange with other farmers. However most farms are still experimenting with rearing techniques and species at the moment.

The institutional framework

Besides expanding size and importance for local livelihoods, the utilization of edible insects and spiders is not yet on the agenda of local or international agencies working in the field of conservation, natural resource management and agricultural extension. Currently there is no institution within Cambodia responsible for detailed edible insect taxonomy or food safety regulations; this keeps the market informal, although consumption and trade have increased in rural and urban areas. Trade volumes nationwide or at provincial levels have not been recorded yet, so data from Thailand are the only statistics available currently (Ratanachan 2009).

Conclusion and recommendations

Cricket and tarantula collection from the wild is contributing to the livelihoods of rural Cambodian households as a source of income and a source of nutrition. However this is still not widely included in food security assessments and the range of utilization and contribution to household consumption and nutrition is unknown.

Furthermore, knowledge about the impact of wild harvesting on biodiversity is very limited with respect to the roles of crickets and spiders as pests and predators. Distribution and origin of the species in the provinces and the migration dynamic of tarantulas and insects are so far untracked; the focus is in the lowland area around Tonle Sap Lake and the surrounding mountain plateaus. Deforestation and conversion of land in rural areas are especially affecting the habitat of tarantulas, which cannot easily adapt to disturbed landscapes.

The tarantula has received much media attention over the few last years but the exact history of consumption in Cambodia is unclear. The popular published viewpoint is that tarantula was consumed against starvation during the Khmer Rouge era. However, in this survey it was reported that consuming tarantulas has a much longer history.

Crickets are being increasingly consumed after people started trapping them for retail. Unregulated wild trapping may lead to decline in wild stocks, driving some people out of business again, while others will specialize in domesticated mass rearing.

Culturally, rural and urban Cambodians appear to have enjoyed consuming insects and spiders as a snack. However with changing lifestyles in urban centres such consumption habits might soon change to ‘food for the poor or a fun snack’ but further investigations on consumer behaviour and preferences need to be carried out.

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Indigenous small fish in rural areas for sustainable use and management: growth and reproduction of *Esomus metallicus* in central Lao PDR

Shinsuke Morioka[1] and Bounsong Vongvichith[2]

The striped flying barb Esomus metallicus *is a small indigenous cyprinid found profusely in the plains of Lao PDR; it is an important edible protein resource in rural areas. However, its biological survey, relevant to future stock management and conservation for sustainable use, has been minimal so far. In this context growth and reproduction of* E. metallicus *in central Lao PDR were investigated via daily age analysis (using otoliths) and gonad analysis of the species collected during different temperature periods, i.e. low temperature periods (November 2009, February to March 2010) and high temperature periods (May to June 2010). Growth patterns in these three periods were each estimated on the basis of daily age (*t*) and size (*Lt*) relationships and were fitted by the following Gompertz curves;* $Lt = 46.00 \cdot exp[-2.19 \cdot exp(-0.026 \cdot t)]$ *in November,* $Lt = 40.11 \cdot exp[-2.34 \cdot exp(-0.029 \cdot t)]$ *in February to March and* $Lt = 41.72 \cdot exp[-2.46 \cdot exp(-0.057 \cdot t)]$ *in May to June, respectively. The formulae show that growth during the high temperature period was significantly faster than in the low temperature periods. Based on gonad analysis (gonad somatic index, percent) on females, the reproduction of* E. metallicus *was more active during high temperature periods than in low temperature periods. Further, differences in oocyte diameters in various size ranges suggested the maturation size of this species to be larger than 40 millimetres standard length with oocytes of approximately 0.5 millimetres in diameter.*

The simultaneous occurrences of various-sized/aged specimens regardless of periods and widely varied hatching periods indicate that this species breeds almost throughout the year.

Keywords: *Esomus metallicus*, otolith, growth, reproduction, Lao PDR

Introduction

The striped flying barb *Esomus metallicus*, locally called *Pa sieu* in Lao PDR, is a small cyprinid distributed widely in tropical and subtropical freshwaters. It originated in Lao PDR, Thailand, Myanmar, Cambodia, Viet Nam and northern Malaysia (Rainboth 1996; Kottelat and Whitten, 1996; Kottelat, 1998, 2001) but was introduced to Singapore (Ng *et al.* 1993). This species inhabits lowlands and is often found in rice paddies, reservoirs, swamps and irrigation canals (Kottelat 1998; Vidthayanon 2002) throughout the year. Its standard length reaches over 70 millimetres (Rainboth 1996). Because of its wide distribution and proximity to peripheral farmers, this species is an important edible protein resource in inland farming communities of the region often being dried or fermented, and occasionally eaten raw (Tomokawa *et al.* 2008). In recent years, however, there has been potential for stock decline because of environmental changes (for example urbanization and land exploitation for cropping). There is a need to obtain biological information on the

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species for future stock assessment and sustainable utilization. In addition, nearly 20 invasive exotic fish species have recently been reported as having established breeding populations in the Mekong River Basin (Phillips 2002; Welcomme and Vidthayanon 2003), a strong reason for conservation of the region's native/endemic fish species diversity, including *E. metallicus*. For fish diversity conservation as well as stock assessment relevant to sustainable utilization, information on the life history of this species, such as growth, sexual maturity and generation time, is a basic requirement, in addition to further considerations on phylogenic status within the genus and related groups. However, research on these aspects has been minimal so far for *E. metallicus*.

This study aimed to analyse growth and the size/timing/age at sexual maturation of *Esomus m etallicus* based on an analysis of otolith daily increments and gonads. In addition, observations on gut contents were made in order to obtain information on food supply at the collection sites.

Materials and methods

A total of 238 *Esomus metallicus* individuals were used in the study (Figure 1). They were collected from a shallow reservoir of approximately 150 square metres and less than 30 centimetres in depth and from an irrigation canal of less than 30-centimetre depth both located in the Namxuang area (44 kilometres north of Vientiane City) and connected by agricultural irrigation canals to the Namgum River, a tributary of the Mekong River (Figure 2). Fish collections were made on 11 and 25 November 2009 (n = 58 and n = 20, respectively), 4 February (n = 19), 3 March (n = 41), 12 May (n = 74) and 3 June (n = 26) 2010. Samples were collected by a seine net (1.5 millimetre mesh, 10 metre width, 1 metre height). Based on the general pattern of monthly average temperature fluctuation (being higher in April to June [25->30°C +] and lower during November to February [20-25°C]) (Morioka *et a l.* 2009), fish samples were divided into two seasonal groups: the fish collected in May to June that had developed under higher temperature (the high temperature group [HTG]) and those collected in November and February to March under lower temperature (the low temperature group [LTG]). Fish samples were preserved in a 70 percent ethanol solution immediately after capture. Although teleost fishes have three pairs of otoliths (sagitta, lapillus and asteriscus), the lapillus was chosen for daily age analysis in the present study because of fragility and structural complexity in the sagitta of cyprinids (Hoff *et al.* 1997). After standard length (SL, in millimetres) measurement, the otoliths (lapilli) were removed under a dissecting microscope and mounted in epoxy resin on glass slides. They were ground (when opaque) using sandpaper (# 1 500) and lapping films (6 and 9 μm mesh). The ground otolith surfaces were occasionally etched by 0.1 N hydrochloric acid to emphasize increment contrast. Otolith increments were observed and counted under an optical microscope with transmitted light (× 200-1 000).

Figure 1. Adult striped flying barb, *Esomus metallicus* (42.0 mm SL) (courtesy Morioka *et al.*)

As otoliths were removed, gut contents were simultaneously observed for feeding habit observation. In addition, the ovaries of females (37 specimens in November 2009, 34 in February-March and 74 in May-June specimens) were removed and weighed as body weight (grams) for the gonad somatic index (ovary weight/body weight × 100 percent). For 22 females collected in June, the diameters of oocytes were measured, and the oocyte number per female was estimated by means of the number-weight relationship of oocytes, as follows: $WON = (WOW \times PON)/POW$, where WON, WOW, PON and POW were the whole oocyte number per female, whole ovary weight (grams) per female, partial oocyte number and partial ovary weight (grams), respectively.

Figure 2. Map of Lao PDR showing the collection site

Results

Characteristics of fish collection sites: The pond and irrigation canal from which the fish samples were collected contained water throughout the year. The shore and part of the bottom of the pond comprised leaf mould and fine mud, and the river bottom various-sized pebbles and sand; both had bank vegetation.

Age and growth: Daily increments were clearly observable in the otoliths (lapilli) (Figure 3). Daily ages estimated on the basis of otolith increment counts were 49-117 (26.3-43.1 millimetres SL, $n = 78$) in November 2009, 46-110 (27.5-47.4 millimetres SL, $n = 78$) in February to March 2010, and 39-118 (25.0-47.4 millimetres SL, $n = 60$) in May to June 2010, the former two being the LTG and the latter the HTG. Their growth patterns were fitted by the Gompertz formulae, as follows; $Lt = 46.00 \cdot \exp[-2.19 \cdot \exp(-0.026 \cdot t)]$ in November specimens, and $Lt = 40.11 \cdot \exp[-2.34 \cdot \exp(-0.029 \cdot t)]$ in February to March specimens and $Lt = 41.72 \cdot \exp[-2.46 \cdot \exp(-0.057 \cdot t)]$ in May to June specimens (Figure 4), where Lt and t denote the fish standard length and the age in days, respectively. These formulae indicated that the growth of the latter (the HTG) was significantly faster than the former two (the LTG) (F-test, $p < 0.001$), although the difference was not significant between the two formulae of the LTG.

Figure 3. Otolith (lapillus) of *Esomus metallicus* (32.4 mm SL). Scale bar: 100 µm
Source Morioka *et al.*

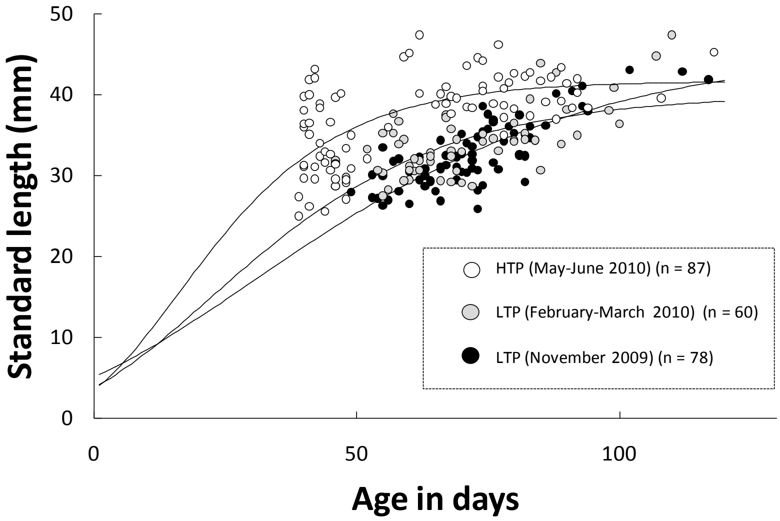

Figure 4. Growths of *Esomus metallicus* occurring in different periods

Source: Morioka *et al.*

Feeding habits: Most specimens collected during high and low temperature periods had considerable gut contents; the major organisms found in the gut were phytoplanktonic algae, including green algae (*Cosmarium* spp.), blue-green algae (*Stigonema* spp.) and diatoms (*Achnanthes* spp.); detritus of unknown species were also often found. However, the animal contents (e.g. zooplankton and insect larvae/adults) were very low. This result suggested that *Esomus metallicus* is herbivorous in the collection sites of the present study.

Gonadal development: The gonad somatic index (GSI, percent) in the fish samples collected in November 2009 (the LTG) was low in all size ranges from 25.0 to 45.0 millimetres standard length (Figure 5). The GSI subsequently increased slightly in the fish samples collected in February to March 2010 (the LTG), and further increased in the fish samples collected in May to June 2010 (the HTG) in which the GSI reached approximately 15 percent or more in specimens larger than 40 millimetres standard length (Figure 5). In addition, comparison between oocyte diameters in different size ranges of fish showed that the larger oocytes (approximately 0.5 millimetres in diameter) were found in fish larger than 40 millimetres standard length and the smaller ones were found in fish smaller than 40 millimetres standard length (approximately 0.2-0.4 millimetres in diameter) (Figure 6a);

the relationship between standard length (millimetres) and oocyte diameter (millimetres) being logarithmically deduced by the following formula: $D = 0.43 \cdot \mathrm{Ln}(L) - 1.1$ ($R^2 = 0.79$, $n = 22$) (Figure 6b), where D and L denoted the oocyte diameter and standard length, respectively. These results suggested the maturation size of *Esomus metallicus* as being over 40 millimetres standard length for those with oocytes of approximately 0.5 millimetres in diameter. The oocyte number per fish tended to increase with fish size, the relationship being linearly deduced by the following formula: $O = 129.1 \cdot L - 3142$ ($R^2 = 0.79$, $n = 22$) (Figure 6c), where O and L denote oocyte number and standard length, respectively.

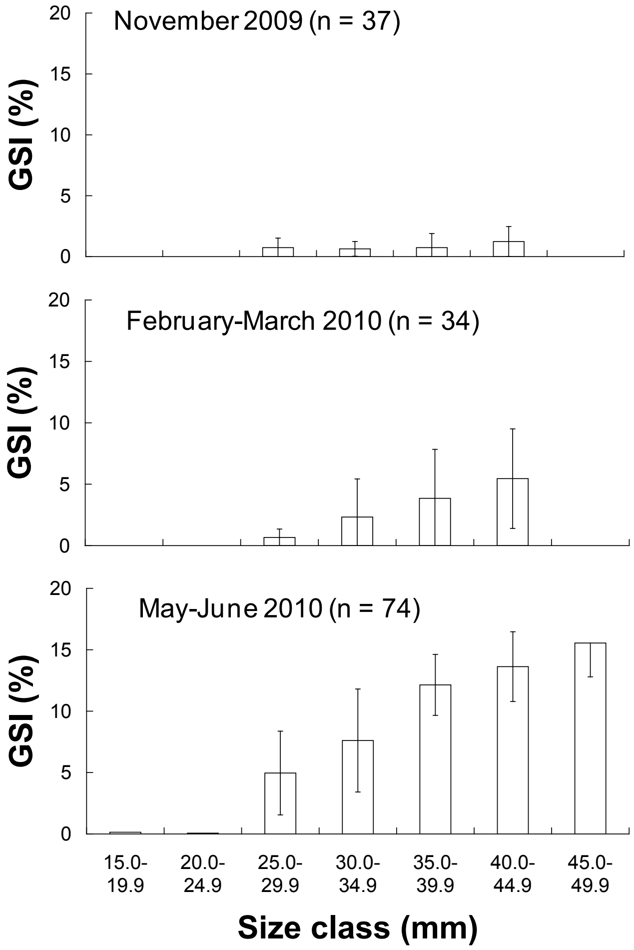

Figure 5. Gonad somatic index (GSI, percent) of female *Esomus metallicus* in different temperature periods

Source: Morioka *et al.*

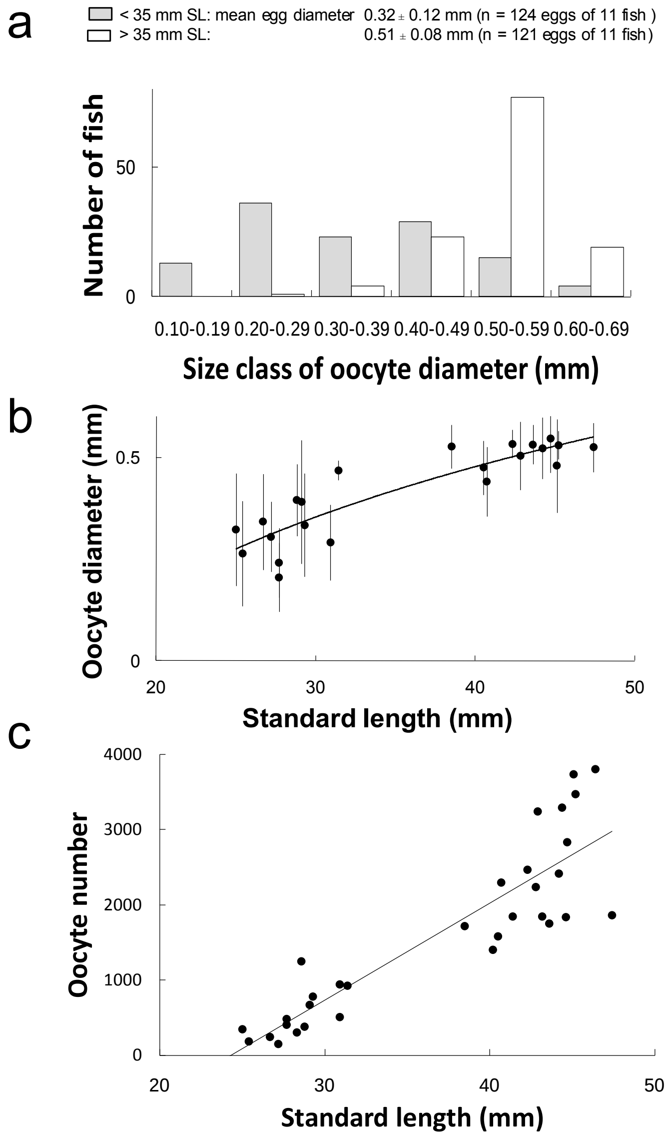

Figure 6. (a) Frequency distributions of oocyte diameter in different size class of *Esomus metallicus*. (b) Relationship between standard length and oocyte diameter. (c) Relationship between standard length and oocyte number

Source: Morioka *et al.*

Discussion

In the present study, the growth of *Esomus metallicus* during the HTP was significantly faster than that during the LTP (Figure 4). As most of the collected specimens had considerable amounts of food material in their guts, regardless of periods and fish sizes, nutritional conditions were sufficiently stable in collection sites almost throughout the year. These results indicate that the differences in growth rates by periods are attributable to the difference in temperature. Similar phenomena were reported in the sympatric fishes in different taxa, for instance *Brachygobius mekongensis* (Gobiidae, see Morioka and Sano 2009) and *Parambassis siamensis* (Ambassidae, see Okutsu *et al*. 2011). On the basis of both the growth patterns (Figure 4) and the maturation size of females more than 40 millimetres standard length, *E. metallicus* tended to grow relatively faster both in the high and low temperature periods before sexual maturation; the growth rate slowed after sexual maturation (Figure 6a, b) at 60 to 70 days during the HTP and approximately 100 days during the LTP. These results coincided with earlier reports showing that higher temperature causes faster maturation and growth within the species (Dotsu 1982; Kon and Yoshino 2002; Morioka and Kaunda 2005). These short maturation times indicate occurrence of plural generation alternations within a year, also reported in other sympatric fish such as *B. mekongensis* and *P. siamensis* (Morioka and Sano 2009; Okutsu *et al*. 2011). The oocyte number increased with fish size and the maximum number was estimated at approximately 3 000 to 4 000 oocytes per female in the present study (Figure 6c). However, as the maximum size of the species is reported at over 70 millimetres standard length (Rainboth 1996), maximum fecundity is probably more than that estimated here. Furthermore, the simultaneous presence of small/young and large/aged specimens regardless of periods suggests that *E. metallicus* breeds throughout the year, although the breeding peak is observed during the HTP (Figure 5). Such prolonged breeding in subtropical and tropical areas is often reported in various taxa, for example the aforementioned *B. mekongensis* (Gobiidae), *P. siamensis* (Ambassidae), *Anabas testudineus* (Anabantidae, see Morioka 2009), *Corynopoma riisei* and *Corydoras aeneus* in Trinidad (Characidae and Callichthyidae, respectively, see Alkins-Koo 2000).

Esomus metallicus was observed to be highly herbivorous (mainly phytoplanktonic algae) at the collection sites of the present study, this observation coinciding with analysis of the stable isotope of the species (A. Mori, unpublished data). In contrast, the sympatric fish *Parambassis siamensis*, often collected simultaneously with *E. metallicus*, was reported to be highly zooplanktivorous and insectivorous (Okutsu *et al.* 2011). This difference in feeding habits illustrates clear species segregation on the basis of food items among these two sympatric fishes. However, according to an earlier description (Rainboth 1996), *E. metallicus* is planktivorous/insectivorous. Considering these different observations, *E. metallicus* may be omnivorous (adaptable from algae to zooplankton/insect feeding) and its feeding habit can vary by fauna and flora in the habitat, although further investigation is needed.

In addition, Tomokawa *et al.* (2008) reported that consumption of raw small-/middle-sized cyprinids, including *E. metallicus*, causes a risk of parasitic infection (*Opisthorchis viverrini*) in south-central Lao PDR; however they also indicated that *Esomus metallicus* was an important edible protein resource in rural areas. Thus there is a need to publicize such infection risk caused by eating raw fish and the manner of preparation (cooking and process methods) as well as stock management and sustainable use. Some cyprinids (*Parachela siamensis* and *Rasbora tornieri*) contain high vitamin A and contribute to public health improvement in rural societies (Roos *et al.* 2007); more detailed investigations on various fishes in this context are required.

Acknowledgement

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Farming insects for food in Thailand

Yupa Hanboonsong[1]

*Thailand is well known for edible insect consumption and trade. Over 164 insect species are eaten in all regions throughout country. Edible insect species are obtained from both wild harvesting and farming. Two types of edible insects (cricket and palm weevil) are commonly farmed in the northeastern and southern regions of Thailand respectively. The native cricket species (*Gryllus bimaculatus *and* Teleogryllus testaceus*) and introduced house cricket species (*Acheta domesticus*) are popularly farmed and reared on a commercial chicken feed. Farming palm weevil (*Rhynchophorus ferrugineus*) by using sago palm as a feed source restricts farming to areas where sago palm is grown. Farming of edible insects can provide an alternative food protein source that could become a new food industry that uses less space and contributes to a less-polluted environment.*

Keywords: Edible insect farming, crickets, palm weevils, Thailand

Introduction

Insects offer a good source of nutrients and are comparable to conventional animal sources with high protein content. In general, insects are a good source of energy, protein (20-70 percent of raw protein), amino acids (30-60 percent), fats (10-50 percent), minerals and vitamins important for human health. Insects are especially rich in phosphorus, potassium, iron, copper, zinc, manganese, sodium, vitamins B1 and B2 and niacin (Nutrition Division 1992). Nutritional values vary according to the species of insect and how they are prepared for consumption. Several studies have established reference nutritional values for various edible insect species (Klinhom *et al*. 1984; Lewvanich *et al*. 1999; Lumsa-ad 2001). Insects are eaten in more than 113 countries in Africa, Asia, Central America and South America. It is estimated that 1 500 insect species are used as food (MacEvilly 2000).

Edible insects and entomophagy in Thailand

Eating insects (entomophagy) is common in Thailand. Traditionally insect consumption occurred mainly in the northern and northeastern rural regions. Nowadays this habit is spreading widely across the country. Eating insects is no longer seen as an activity for poor people; nowadays even high-income earners consume insects. It was reported that approximately 164 edible insect species are eaten in Thailand (Lewvanich *et al*. 2000). Some insects are commonly sold in markets and they are the favourite species. For instance, the giant water bug and grasshoppers are eaten throughout the country. Predaceous diving beetles, water scavenger beetles and immature weaver ants are also eaten widely (Hanboonsong *et al*. 2000). Bamboo caterpillars (*Omphisa fuscidentalis*), silkworm pupae and house crickets (*Acheta domesticus*) are popular in the northern region. Wasps, bees and palm weevil (*Rhynchophorus ferrugineus*) are well-known edible insects in southern Thailand.

Insects most commonly marketed and consumed in Thailand come from both wild-harvested and farmed sources (Table 1). Farmed insects such as crickets and silkworm pupae can be found throughout the year while wild-harvested species such as grasshoppers and weaver ants occur seasonally.

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Table 1. Insects most commonly marketed and consumed in Thailand

Common name	Scientific name	Seasonal occurrence
Bombay locust	*Patanga succuncta* L.	August-October
Oriental migratoria locust	*Locusta migratoria manilensis* (Meyen)	June-July
Domestic house cricket	*Acheta domesticus* L.	All year (farmed)
Common/field cricket	*Gryllus bimaculatus* De Geer	All year (farmed and harvested)
Common/field cricket	*Teloegryllus testaceus* Walker	All year (farmed and harvested)
Mole cricket	*Gryllotalpa africana* Beauvois	May-July
Short-tailed cricket	*Brachytrupes portentosus* Licht	October-November
Giant water bug	*Lethocerus indicus* Lep.Serv.	July–October
Predacious diving beetle	*Cybister limbatus* F.	July–October
Water scavenger beetle	*Hydrous cavistanum* Bedel	July–October
Bamboo caterpillar	*Omphisa fuscidenttalis* Hampson	August-November
Silkworm pupa	*Bombyx mori* L.	All year (farmed)
Scarab beetle	*Holotrichia* sp.	May-August
Red ant/weaver ant	*Oecophylla smaragdina* F.	March-May
Palm weevil larva	*Rhynchophorus ferrugineus* Oliver	All year (farmed)

A

B

Figure 1. Commonly marketed and consumed edible insects in Thailand: (a) grasshoppers; (b) bamboo caterpillars (courtesy Y. Hanboonsong)

Edible insect farming

In the past all species of edible insects were harvested in the wild. But nowadays farming techniques have been developed for some species. House crickets (*Acheta do mesticus*), palm weevils (*Rhynchophorus f errugineus*) and mealworms (*Tenebrion m olitor*) are successfully farmed in Thailand. House crickets and palm weevils are used mainly for human consumption, while mealworms are commonly used as pet foods (for fish, birds and geckoes or lizards).

Cricket farming

At the start of technology development for cricket farming in the northeast in 1996, two common cricket species *Gryllus bimaculatus* De Geer and *Teleogryllus testaceus* Walker, both native to the region, were introduced to farmers. However, a few years later, the house cricket (*Acheta domesticus*), commonly called *sading*, was brought in to replace the native crickets and now is commonly farmed in the northeast and other parts of Thailand (Figure 2). The farmers prefer to breed house crickets rather than native cricket species even though the period of development from egg to adult of the two cricket species is similar (45 to 60 days). The main reason for this preference is that house crickets have a better taste, particularly the females because of the many eggs inside their abdomens; the eggs are delightfully crunchy.

Cricket-breeding techniques have not changed since they were first introduced. House crickets are bred in various containers such as concrete tanks or concrete block pens covered with a mosquito or nylon net to keep crickets in and predators out. Bedding is often made from a layer of rice husks but some breeders do not use any material. Cardboard egg cartons are often used to provide crickets with a place to hide. The most commonly used food for crickets is commercial chicken feed with 14 to 21 percent protein content, and a few days before harvest, pumpkins or vegetables. As soon as the male crickets stridulate, bowls containing a mixture of husk and sand are placed in the breeding enclosure for crickets to lay eggs in. After a few days, the bowls are moved to another breeding tank for incubation and hatching at a stable temperature. This reproduction cycle can be repeated one to three times for each generation. It takes 40 to 45 days from the egg stage until harvesting of the adults.

Three kinds of products (mature crickets, cricket eggs and fertilizer from waste produced from the cricket farms) can be sold. However, the main product is the adult crickets. Cricket breeders usually sell their crickets through wholesale buyers who supply market vendors or restaurants, and sometimes directly to local consumers or to gecko or fish breeders for feed.

In order to promoting public awareness of cricket farming, including cricket consumption and stimulating the market demand for crickets, many related activities have been undertaken. One, beginning in 1996, was the introduction of small-scale cricket farms for students at primary schools. This activity not only provided education by integrating the cricket-farming activities with school extra-curricular subjects, but also produced additional protein for the student school lunch programme. These integrated cricket-breeding lessons at the school level were quite successful and the students enjoyed having cricket farms at their school. Moreover, cricket cooking fairs and competitions were also occasionally organized for public awareness purposes.

A

B

C

Figure 2. Cricket farm in Khon Kaen Province. (a) House cricket (*Acheta domesticus*); (b) common cricket (*Gryllus bimaculatus*); (c) breeding containers. Courtesy Y. Hanboonsong)

Palm weevil farming

The palm weevil (*Rhynchophorus ferrugineus* Oliver) is found mainly in the southeast region of Thailand. Local people have been breeding palm weevil on *lan phru* trees (cabbage palm, *Corypha utan* Lam.) and sago palm (*Metroxylon sagu* Rolth.) since 1996 for home consumption (Figure 3). Palm weevil larvae became a popular food for people in the southern region and other areas around 2005. Because of this increase in demand, palm weevil breeding has expanded into commercial-scale farming in many provinces in the south of Thailand.

Palm weevil breeding still depends on natural plant food so up till now palm weevil farming cannot be expanded into other regions where *lan phru* trees and sago palm are not found.

Two breeding methods are used for palm weevil farming. The traditional method is breeding directly in palm trunks or stems. Cabbage palm or sago palm trunks or stems are cut into 50-centimetre lengths and adult males and females are released on top. After 40 to 45 days palm weevil larvae can be harvested. The second method is a modification of the traditional technique. Breeding takes place in a plastic container. Instead of using an actual palm tree, a round plastic container filled with ground palm stalk and mixed with pig feed is used.

Feed formula for each insect species farmed

Approximately half of the production cost of insect farming is in the feed which is commercially produced for the chicken industry. Therefore cricket farming is vulnerable to price increases in that sector. This potential risk could undermine profitability for cricket farming. Research is needed to find low-cost or free protein sources to develop into a special feed formula for crickets. Palm weevil depends on natural food sources like sago palm trees. Accordingly there is the risk that palm trees will be threatened by overharvesting and pressure from ecological organizations may create a negative image and limit consumer acceptance, especially if the consumer base is to expand to Europe and the United States.

Figure 3. Palm weevil farming in southern Thailand. (a) Adults and larvae; (b) sago palm tree; (c) plastic container filled with ground palm stalks and mixed with pig feed; (d) breeding colonies; (e) sago worm dish. Courtesy Y. Hanboonsong

Constraints and threats to edible insect farming

Disease

Currently disease in insect farms is almost non-existent. However, in the future with increasing intensive insect farming and insufficient farm management guidance, potential virulent diseases could wipe out an entire insect farm, and spread to other production sites. Therefore there is a need for standard farm management practices for cricket rearing from nursery to harvest. A reporting system and a central database for emerging diseases is also highly desirable so that new pathogens are rapidly identified and measures to control them are put in place. It is also essential to determine the potential threat to humans of the consumption of infected insects. Lastly there is a need for extension workers or technical staff with experience and knowledge of these key factors to train farmers.

Access to a wider consumer base

Perhaps the biggest challenge for insect farming is acceptance of edible insects by mainstream consumers. Although their nutritional value and limited environmental impact have been clearly demonstrated, cultural barrier have to be overcome before people who are not used to eating insects (most of us) learn to do so. This could start as a fashion phenomenon before becoming a mainstream food habit.

Conclusion

Although insect consumption has occurred in Thailand for many centuries, the farming of specific species for food is a comparatively new development. Initial research into commercial breeding was carried out by a few researchers and local enthusiasts who established the practices that are now used widely in the insect farming industry. To date only two groups of insect (cricket and palm weevil) have been developed for commercial production, despite nearly 200 species known to be edible. There is therefore huge potential to develop production and management techniques for some of these unfarmed species.

As availability of farmed products becomes more common in Thailand the popularity of eating insects as a food continues to rise. Successful school programmes to promote cricket breeding have exposed more people to eating and rearing techniques and the popularity of insects for human consumption is bound to rise. But insect farming in Thailand faces some challenges. The feed supply for the two commonly farmed species is expensive on the one hand and possibly not ecologically sustainable on the other. New research into alternative feed supplies for these farmed species is needed. Disease threat also hangs over the industry due to its intensive nature and because scant research has been conducted on hygiene factors and disease risks which could be catastrophic. However there appears to be a bright future for insect farming in an overpopulated world that constantly demands new protein sources.

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CHAPTER 3
Papeda sago porridge, a staple food in Indonesia

Gayatri K. Rana[1]

Rice is staple food for most of Indonesia (population 237.6 million in 2010). Rice consumption was around 33.0 million tonnes per annum *in 2010 and production comprised approximately 37.2 million tonnes. However, people in some areas also consume other staple food made from sago, cassava, sweet potato, maize and other grains and tubers.*

Papeda is made from gluten-free sago starch extracted from Metroxylon sagu *Rottb. It is consumed in provinces such as Papua, West Papua, Maluku, North Maluku, Southeast Sulawesi, South Sulawesi, Riau, West Kalimantan and East Kalimantan. Papeda porridge, rich in carbohydrates, is usually consumed with fish soup, including vegetables.*

With more than 1.38 million hectares of sago plantations, Indonesia has more than 56 percent of sago palm stands in the world. Considering future global food supply threats, all parties involved in food and biofuel development should focus on using sago palm for human consumption and as a source of renewable energy.

Keywords: Papeda, sago, food diversity, Indonesia

Introduction

Sago is a staple food for the people of Maluku and North Maluku provinces in Papua (population 4.0 million in 2010). The sago tree (*Metroxylon sagu* Rottb.) grows in the swampy wilderness near their homes. The tree also provides leaves for roofing and mats as well as other uses.

Carbohydrate from sago pith can be harvested when the tree is at least three years old. All family members participate in harvesting sago and in many areas if this not done they cannot buy it from traders. A family can obtain 150 to 300 kilograms of sago flour from one sago tree to supply staple food for two weeks to one month.

Figure 1. Sago palm trees

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Some people in Papua are ready to switch from sago to rice as their staple food; however the government is emphasizing diversification in consumption of food other than rice, thus recognizing the value of local food. It is important to develop sago, especially when rice production is severely threatened by constantly declining plantation area for other purposes.

Sago palms are typically found in areas unsuited for other forms of agriculture, so sago cultivation is often the most ecologically appropriate form of land use and the nutritional deficiencies of the food can often be compensated for with other readily available foods. Therefore in terms of food security, sago flour can be further developed to strengthen Indonesian food security.

Papeda – staple food

People in Papua and Maluku eat sago flour in the form of sago porridge called Papeda. It is made by ‘cooking’ sago flour in hot water and stirring it constantly until it coagulates. It has a glue-like consistency and texture.

Figure 2. Papeda, fish soup and sautéed vegetables

Papeda has a bland taste and has little nutritive value, therefore it is usually eaten with yellow soup of tuna, Mubara (*Trachinotus carolinus*) or any locally available fish spiced with turmeric, leaves of *Ocimum citriodorum* (Kemangi) and lime.

Vegetables consisting of sautéed flowers of *Carica papaya*, leaves of *Gnetum* sp. and hot chilli are also eaten with this Papeda dish.

According to Ayurvedic medicine, sago porridge can be an effective and simple food to "cool and balance one's body heat" when taking strong medicine or antibiotics.

How to make Papeda

Ingredients

- 100 grams of sago flour
- 1 000 cc of water
- ½ tsp salt
- ½ tsp sugar

Cooking preparations

1. Add 300 cc of water to 100 grams of sago flour. Stir well.

2. Add salt and sugar, to taste.
3. Boil the rest of the water.
4. Pour the hot water gradually into the sago mix, stir slowly until it coagulates, with glue-like consistency and texture.
5. Cooking is finished when the congee colour changes from white to thoroughly transparent or pellucid.
6. When the congee is still uncooked, put the paste of uncooked congee into a pan and keep cooking and stir it over a small fire.
7. Serve the Papeda while hot.

Sago flour

Sago starch contains fibre, carbohydrate, lignin, and hydrogel, which have antimicrobial and antioxidant properties. Thus sago starch can be promoted as a healthy product. To produce good quality sago starch, a tree must reach three to five years of age. Sago is extracted from *Metroxylon* palms by splitting the stem lengthwise into two halves and removing the pith which is then rasped or crushed and kneaded to split the pith into small pieces to release starch from the fibre. Pour water while squeezing by hand or by foot the small pieces of pith and separate the starch from the fibrous residue by straining. Repeat until the starch is completely released from the fibre. The raw starch suspended in water is then collected in a settling container.

Every 100 grams of sago flour contains 94 grams of carbohydrate − more than flour made from rice, potato, maize or wheat − and approximately 355 kcal. The contents of five different flour types are given in Figure 3.

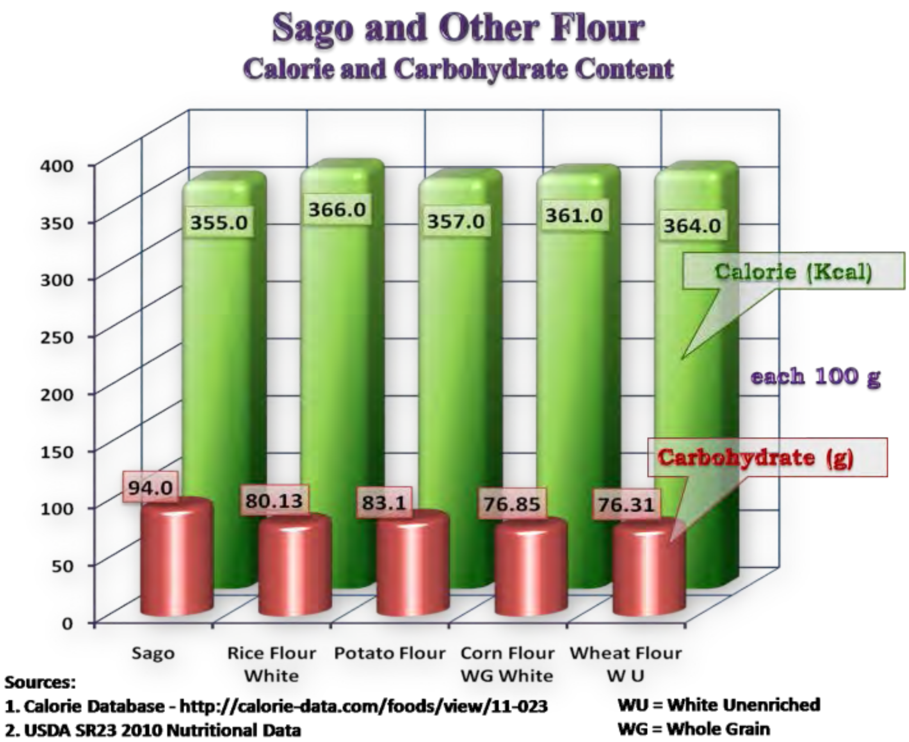

Figure 3. Sago and other flour: calorie and carbohydrate content

Papeda nutrititive qualities

As Papeda is made from pure sago flour, it is rich in carbohydrate but quite low in protein, vitamins and minerals; it has a low glycemic index and is gluten free. In comparison, rice, wheat and maize have much higher levels of protein, vitamins and minerals. They are almost always eaten with a variety of nutritious vegetables, fish and meats.

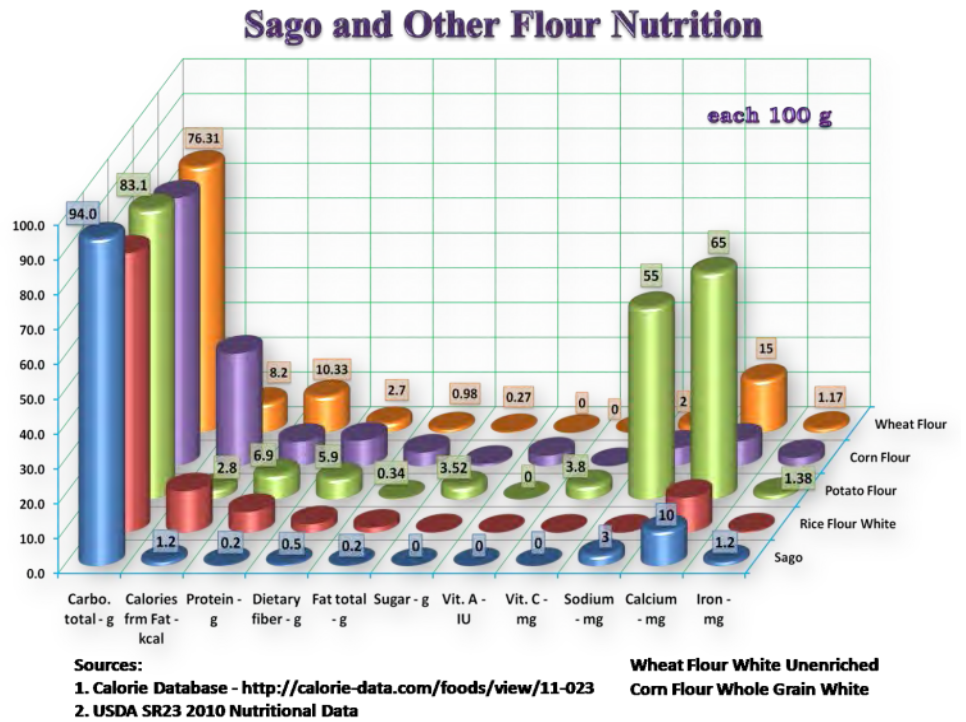

Figure 4. Nutrition from sago and other flour

Dry sago (100 grams) typically comprises 94 grams of carbohydrate, 0.2 grams of protein, 0.5 grams of dietary fibre, 10 milligrams of calcium, 1.2 milligrams of iron and negligible amounts of fat, carotene, thiamine and ascorbic acid − it yields approximately 355 kcal. Comparison of sago nutrition and that of other flour is given in Figure 4.

Future use of sago in Indonesia

In 2010, Indonesia needed around 32 million tonnes of rice to feed more than 237 million people. After 35 years (in 2045) the Indonesian population is estimated to rise to 400 million people. If rice production cannot be increased and per capita rice consumption cannot be reduced, it is estimated that Indonesia will need to import about 25 million tonnes of rice.

A sago tree can produce 200

to 400 kilograms of carbohydrate; some varieties can produce 800 kilograms per tree. Therefore an intensive sago tree plantation with 100 to 200 trees per hectare with an average of 300 kilograms of carbohydrate/tree can deliver 30 to 60 tonnes of carbohydrate/hectare/year. There are approximately 4 million hectares of swamp suitable for agriculture in Indonesia. If only 1 million hectares are carefully utilized for sago tree plantation, this could supply enough carbohydrate for the population.

Sago palms can also be used as multi-purpose species or in agroforestry. The tree tolerates low pH, high Al, Fe and Mn in the soil as well as heavy impervious clays. Sago palm can grow well in peat swamps unlike other crops. However, sago palm is not a well-established crop but a semi-wild species.

Sago forests also serve as sinks for carbon dioxide thus contributing to climate change impact mitigation.

Figure 5. Sago pith splitting (left) and pith rasping (right). Courtesy Rana

Potential of sago to enhance food security

There are around 1.2 million hectares of wild stands of sago tree in Indonesia and around 60 to 85 percent are found in Papua. The sago tree is known for its high productivity in producing carbohydrate compared to cassava and potato. Sago trees in the wild can produce dry carbohydrate of around 25 tonnes/hectare/year while cassava and potato produce only 10 to 15 tonnes/hectare/year. Figure 6 depicts the strong productivity of sago trees compared to other food plants.

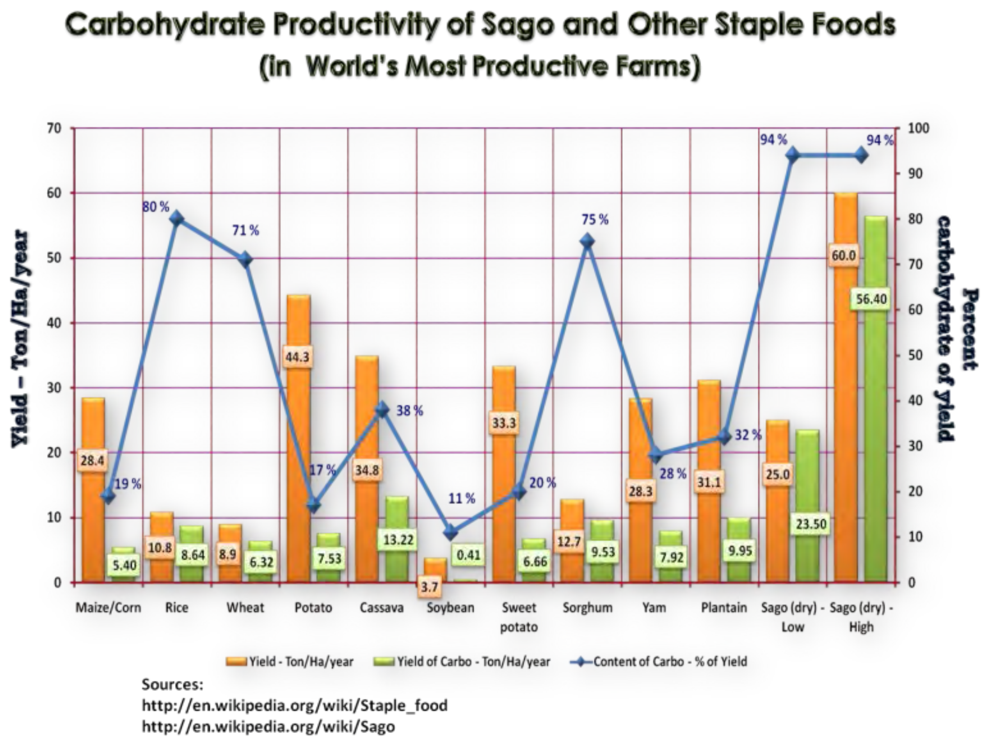

Figure 6. Carbohydrate productivity of sago and other staple foods

The 1.38 million sago trees of Indonesia spread from Sumatra to Papua (Flach 1979). They grow mostly in semi-wild stands and are still underutilized. However development is underway through food diversification schemes for utilization of local food other than rice. Sago flour, cassava, sweet potato and other carbohydrate sources are being seen as means to support Indonesian food security.

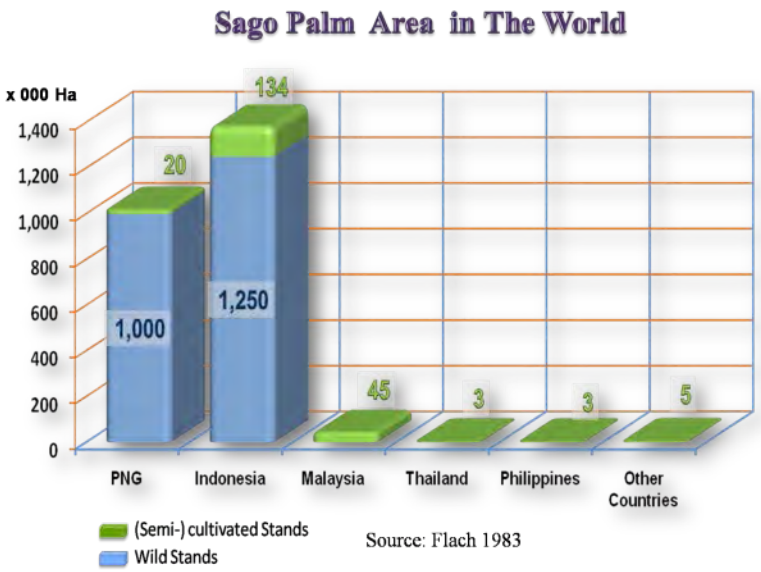

Figure 7. Sago palm distribution worldwide

Although sago trees grow mostly in Indonesia and Papua New Guinea (Figure 7), if they are professionally managed, they have potential to reduce hunger in the Asia-Pacific region and elsewhere.

Other potential uses of sago

There is potential for sago palm to be used for ethanol production. Throughout its life cycle, the tree accumulates vast amounts of starch, peaking at about 15 years of age before its (single) inflorescence occurs.

However renewable energy for industry and transportation can be developed from other sources such as solar power, hydropower, wind and other non-food plants, so the exploitation of sago palm for energy should be strongly avoided because of its potential for contributing to the achievement of food security.

Rhynchophorus spp – a hidden delicacy in sago palm

Grubs, especially *Rhynchophorus* spp., may grow in the decaying trunks of sago palms. The grubs are eaten fresh or roasted. The Kamoro people of Papua believe that the sago larvae contain many vitamins. They owe good health to the consumption of these grubs. There is merit in this belief as a study found that sago larvae are nutritious and cholesterol free. They have 6.9-9.34 percent protein; 8.5 percent carbohydrate; 11.3 percent fat; 1.84 percent aspartic acid; 2.27 percent glutamic acid; 1.87 percent tyrocine; 1.97 percent lysine; and 1.07 percent methionine. The larvae belong to the sago palm weevil or red palm weevil (*Rhynchophorus ferruginous*).

Figure 8. *Rhynchophorus* grubs (courtesy Rana)

To 'farm' these larvae, local people cut down the sago palm and leave it in a water-logged area. The sago palm weevils deposit eggs inside these rotting sago trunks and the developing larvae grow rapidly within.

Figure 9. Grilled sago grubs (courtesy Rana)

The grub is also considered a delicacy in much of Southeast Asia and Papua New Guinea. Sago grubs have been described as creamy tasting when raw and like bacon when cooked. They are often prepared with sago flour.

Conclusion

Sago starch contains fibre, carbohydrate, lignin and hydrogel, which have antimicrobial and antioxidant properties. As such, sago starch should be promoted as a healthy food resource.

Utilizing sago starch, especially at industrial scales in plantations, may provide an alternative resource in the thrust for food security via crop diversification. This could result in significant production to alleviate demands on rice by the growing population. Sago palm plantations may also play an important role in combating the impacts of climate change.

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Common local dishes from wild ingredients in northeastern Thailand

Gassinee Trakoontivakorn,[1] Plernchai Tangkanakul,[1] Jintana Yhoung-aree[2] and Lisa Price[3]

Foods in different regions of Thailand are distinctive in taste, appearance and ingredients, especially plants. Edible plants in each region vary according to the local topography. They are generally young leaves, flowers or fruit collected from trees, bushes, vines and herbaceous plants This study was conducted in two villages in Kalasin, a province in the northeast of Thailand. Vegetables and mushrooms consumed by villagers were mostly wild species gathered from rice paddy fields, hillocks in fields, empty land around houses, groves or purchased from the market. Fourteen local dishes were identified. Vegetables and mushrooms were consumed either raw or cooked. Cooking treatments comprised parboiling, boiling, steaming, grilling and baking. Some vegetables were always cooked. From individual interviews, 100 edible plants were identified. Eighty-three of them had plain, bitter or astringent taste. Thirteen were herbs to lend a unique aroma or to mask strong meat odour. The rest were used to provide a sour taste.

Keywords: Wild vegetables, local cuisine, northeastern Thailand

Thailand is divided into the northern, northeastern, central and southern regions; they have their own unique local dishes that are distinctive in taste, appearance and ingredients. Plants consumed vary according to topography: mountains and forests in the north, semi-arid farmlands of the northeast, vast rice fields of the Central Plains and the long coastline of the southern peninsula. However, edible plants in any region comprise young leaves, flowers, fruit from trees, bushes and vines, as well as aquatic and herbaceous plants.

This study was conducted in Kalasin, a province in the northeast, located east of Khon Kaen, during July to December, 2006. Two villages, Ban Sa-at Tai (*muu* 4) and Ban Sa-at Somsri (*muu* 9), located in the suburbs of the city of Kalasin were used for data collection (via focus group discussion and individual interviews).

Seven focus group discussions were conducted. Four comprised villagers from Ban Sa-at Tai, the other three came from Ban Sa-at Somsri. The groups had six to nine participants. For individual interviews, 18 houses were visited in Ban Sa-at Tai and 46 houses from Ban Sa-at Somsri. Recipes containing wild edible plants were discussed. Demonstration of preparation and cooking methods was conducted. The popularity and frequency of consumption of various edible plants were documented.

The women prepared three meals a day. Individual interviews revealed that about 30 percent of households ate between meals, but rarely (10 percent) before bedtime. All family members ate together at dinner. Food was prepared before darkness fell. The cooking area was outside the house and wood/charcoal burning clay stoves were

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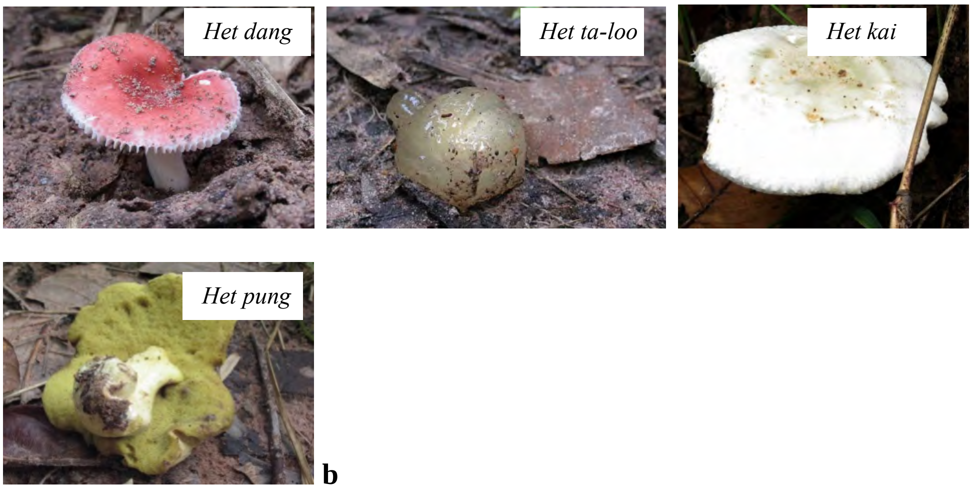
preferred. Kitchen utensils were stone mortar and pestle (essential), pots, knives and cutting boards. In the northeast, hereafter referred to as *Isan* (Thai vernacular), a stone mortar and pestle is needed to make a nicely textured curry paste.

Protein and vegetable sources

Beef, chicken, pork, paddy rats, birds, fish, tadpoles, frogs, paddy crabs, freshwater shrimp and pond snails were available protein sources for villagers. During the study, the most frequently mentioned were fish, frogs, paddy crabs, paddy snails, chicken and beef. Vegetables and mushrooms were gathered from rice paddy fields, hillocks in the fields, empty land around house and groves or they were purchased from vendors or the village co-op. From individual interviews, 96.8 percent of the respondents indicated that vegetables they cooked grew naturally. Other options were wild species around their houses, 90.5 percent; cultivated species around their houses, 61.9 percent; purchased species, 42.9 percent; sharing with neighbours, 34.9 percent; and exchange, 1.6 percent. The villagers defined 'naturally grown vegetables' as edible plants that grow without special care such as dosing with pesticide, herbicide and fertilizer, or not grown from commercial seed.

Villagers in the studied area obtained their food from rice paddy fields, a swamp near the village, along paths or around their houses. Vegetables were picked daily, preferably before cooking if they were collected around houses. They indicated that freshly picked vegetables made their food tastier. Villagers would sell wild plants, mushrooms and insects in their hamlets if large amounts were collected. These items would be cooked within that day. During our visits, villagers were selling lotus stems and wild mushrooms. Lotus stems were collected from a swamp and mushrooms from groves. In one grove, many species of wild mushrooms were found. Villagers often sold mixed lots of wild mushrooms.


a



b

Figure 1. (a) Foraging for food in a grove; (b) various edible Thai mushrooms (courtesy Trakoontivakorn)

The most common protein sources were fish and paddy crabs or frogs in the rainy season or paddy rats during rice harvesting. *Pla kor* (snakehead fish) was the most common fish. Villagers kept them alive in earthenware jars. Fish was prepared before cooking other dishes.

Isan food

Fourteen local dishes were identified in the study: *kaeng, aòm, tôm sôm, náam yaa, súp, pòn, mòk, lãam, oã, kâwy, lâap, tam, jàew* and *sôm phàk*. The most commonly eaten were *kaeng, aòm, tôm sôm, súp, pòn, kâwy, lâap, tam* and *jàew.*

Parboiling, boiling, steaming, grilling and baking are the most common methods in the preparation of *Isan* food. Parboiling is used to cook vegetables eaten with *pòn* and *jàew*, both *Isan* chilli sauces. Boiling is used for making *kaeng, aòm, tôm sôm, náam yaa* and oã. These are five different styles of soup. Sometime, vegetables put in *súp* and *kâwy* have to be completely boiled. Steaming is used to prepare vegetables for chilli sauce, to cook fish and some types of *lâap* and *mòk*. Villagers grill *mòk* and *lãam*. Some ingredients for making *súp, pòn* and *jàew* − chilli, shallots and tomato − need to be baked. *Tam* is a culinary genre which cooks without heat. *Sôm phàk* is a fermented vegetable dish.

The characteristics of the 14 local dishes, how to name a dish, important condiments and examples are summarized below.

KEANG: No coconut milk, clear soup or thickening with sticky rice, contains mankinds of vegetables.

Recipe: According to the major vegetables or meat source used (e.g. *Kaeng pla* or fish soup).
Condiments: *Nam pa daek* (fermented fish sauce), fish sauce, chilli.

In this study, ten *kaeng* recipes were identified: *Kaeng nor-mai, kaeng dok-khae, kaeng khee-lek, kaeng bak ue-noi, kaeng waai, kaeng i-loke, kaeng het, kaeng gai, kaeng ple* and *kaeng khied.* The most common is *kaeng nor mai* (bamboo shoot soup). *Nor sang pai* (*Bambusa multiplex*) is preferred. Bamboo shoots are sliced before cooking in *yaa nang* (*Tiliacora triandra*) juice. The juice can eliminate the bitterness of the bamboo shoot.

AÒM: No coconut milk, clear soup or thickening with sticky rice but less water content than *kaeng*, contains many kinds of vegetables.
Recipe name: According to meat source such as *aòm gai* (chicken), *aòm khied, aòm kob, aòm moo, aòm nue, aòm nok, aòm pla, aòm bak hoy.*
Condiments: Fermented fish sauce, fish sauce, chilli.

Figure 2. *Aòm bak hoy* (left), *tôm sôm kob (*right). Courtesy Trakoontivakorn

TÔM SÔM: No coconut milk, clear soup with sour taste from fruit or vegetables.
Recipe name: According to meat source such as *tôm sôm pla, tôm sôm gai, tôm sôm khai, tôm sôm nue* and *tôm sôm kob.*
Condiments: Fish sauce, chilli. Absolutely no fermented fish sauce.

NÁAM YAA: Either with or without coconut milk, contains pounded fish or mushrooms.
Recipe name: According to fish or mushroom source, e.g. *náam yaa het* (mushroom).
Condiments: Fermented fish sauce, fish sauce, chilli.

Figure 3. *Náam yaa het* (left), *oã poo* (right). Courtesy Trakoontivakorn

OÃ: Soup, contains liquidized or finely chopped meat, cooked at low heat.
Recipe name: According to meat source, e.g. *oã poo* (crab).
Condiments: Fermented fish sauce, fish sauce, chilli.

SÚP: Salad-like dish, two categories – with and without *yaa nang* juice, sesame usually added.
Recipe name: According to major vegetables used such as *súp nor mai, súp het, súp bak tang, súp buk khuea, súp hua pli* and *súp bak mii.*
Condiments: Fermented fish sauce, fish sauce, chilli.

Figure 4. *Súp nor mai* (left), *Mòk kob* (right). Courtesy Trakoontivakorn

MÒK: Finely minced meat wrapped in a banana leaf, cooked in a pot or grilled.
Recipe name: According to meat source, *mòk pla, mòk kob, mòk khied, mòk moo, mòk huak*.
Condiments: Salt, fish sauce, chilli. Absolutely no fermented fish sauce.

Figure 5 . *Mòk khied* (right), cooki ng m ethod (left). C ourtesy Trakoontivakorn

LÃAM: Barbecued meat using bamboo as a container.
Recipe name: According to meat source.
Condiments: Salt, fish sauce, chilli. Absolutely no fermented fish sauce.

Figure 6 . *Lãam khied* (right), cook ing m ethod (left). C ourtesy Trakoontivakorn

KÂWY: Salad-like dish, with chopped raw meat or vegetables.
Recipe name: According to major vegetable or meat source, *kâwy dok lin faa* (vegetable), *kâwy hoy.*
Condiments: Fish sauce, chilli, roasted rice.

Figure 7. *Kâwy dok lin faa*. Courtesy Trakoontivakorn

LÂAP: Appearance differs dish by dish, mostly a salad-like dish.
Recipe name: According to major meat source or vegetable, *lâap pla tong (*fish*), lâap nue, lâap kung foi, lâap het ta-loo (mushroom), lâap taw (freshwater algae).*
Condiments: Fermented fish (some dishes), fish sauce, chilli, roasted rice (some dishes).

Figure 8. ***Lâap kung foi*** **(left),** ***lâap pla tong*** **(right),** ***lâap het ta-loo*** **(bottom). Courtesy Trakoontivakorn**

TAM: Salad-like dish, ingredients pounded in a clay mortar with a wooden pestle, spicy, salty and sour.
Recipe name: According to major vegetable.
Condiments: Fermented fish sauce, fish sauce, chilli.

Figure 9. Preparation (left), *tam hua pli* (right). Courtesy Trakoontivakorn

PÒN: Watery dipping sauce.
Recipe name: According to meat source or vegetable.
Condiments: Fermented fish sauce, fish sauce, chilli.

Figure 10. *Pòn pla* (left), *Pòn maa noi* (right). C ourtesy Trakoontivakorn

JÀEW: Dipping sauce.
Recipe name: According to extra ingredient.
Condiments: Fermented fish sauce, fish sauce, chilli.

Figure 11. ***Jàew mang da*** **(left),** ***jàew*** **(right). Courtesy Trakoontivakorn**

SÔM PHÀK: Sour vegetable soup.
Recipe name: According to vegetable used.
Condiment: Salt.

Figure 12. ***Sôm phak sian*****. Courtesy Trakoontivakorn**

It can be concluded that the basic ingredients in *Isan* foods are *yaa nang* juice, fermented fish sauce and lemon basil although they are not found in every dish. *Yaa nang* juice is in fact water extract of *Tiliacora t riandra* leaves. *Pa dae k* is made by fermenting freshwater fish with high salt content and rice bran in an earthenware jar. *Nam pa daek* is the liquid part. In Thailand, four species from the *Ocimum* genus are common herbs: sweet basil, holy basil, lemon basil and wild basil. In the studied villages, lemon basil and holy basil were used in many dishes. Sweet basil is served fresh with *lâap*. There was no specific application of wild basil.

Similar to any other cuisines, vegetables are served either raw or cooked. Vegetables in *kaeng*, *aòm* and *tôm s ôm* are always cooked. As these dishes contain many kinds of vegetables, some vegetables need a longer time to cook. Texture and aroma are important. The order is according to density, with the densest vegetables being adding first and for the longest time. Denser vegetables or parts such as bamboo shoot, rattan stem heart, moringa pod, green onion bulb and vegetable stems require more cooking time than green leafy vegetables. Any soup that contains lemon grass, galangal or chilli will be cooked before adding any vegetables. Aromatic leafy vegetables will be added last or right before removal from the stove. All vegetables in *súp* dishes mentioned in this study are cooked, except coriander, Chinese chive, green onion and sawtooth coriander. Vegetables served with chilli sauces, *pòn* or *jàew*, are raw or cooked. However, only raw vegetables are served with *tam, kâwy* and *lâap.* For *tam*, all dishes are made from raw vegetables.

The most popular edible plants

Edible wild plants consumed in this area came from many plant types. Approximately 130 species were mentioned during our study. Several are general Asian vegetables such as string bean, wood ear mushroom, green onion, coriander, cucumber, tomato, shallot, chilli and garlic.

From individual interviews of 64 households, 100 local vegetables were identified. Thirteen were herbs to give a unique aroma or to mask strong meat odour: lemon basil, holy basil, lemon grass, dill, galangal, kaffir lime leaf, *hom pae, phak khayang*, *phak i-loet* (wild pepper), *phak kha*, saranae (kitchen mint), *phak pael* (Vietnamese coriander) and *bai bak wer*. Four, *tew* (*Gratoxylum formosum*), tender tamarind leaf, *som moong* (*Garcinia cowa*) and *som ob-ab* (*Embelia sucoriacea*) were used to impart a sour taste. The other vegetables were young leaves, pods, flowers or fruit with a plain, bitter or astringent taste.

At least 30 percent of interviewed households rated 27 kinds of vegetable very highly: tender leaves or pods of the lead tree (*Leucaena leucocephala*), water spinach, lemon basil, lemon grass, bamboo shoots, ivy gourd, brinjal (a type of eggplant), *phak tew*, mushrooms, raw papaya, tender leaves and flowers of *Sesbania* sp., *phak khayang*, *phak mek*, *khee lek*, gourd, young shoots of bitter gourd, neem flowers, galangal, water clover, *phak pai, phak kha, phak i-loet* and *phak kradon naam.*

Conclusion

Villagers in Ban Sa-at Tai and Ban Sa-at Somsri, Kalasin Province regularly prepare *Isan* food containing wild food ingredients. Most of the vegetables grow naturally and are gathered from paddy fields and around their houses. In *Isan* food, one kind of dish can have many recipes. The differences come from selecting vegetables/protein sources, which depend on preference or availability.

Wild edible plants in home gardens for improved health and income

Bob Freedman[1]

Home gardens are found in many developing countries and play an important role in contributing to food security, supplementing dietary intake and generating income. Most home gardens contain wild edible plant species that are sources of valuable micronutrients essential for human health, which has been undermined by the introduction of processed food over the last few decades. This has resulted in a plethora of non-communicable diseases. Thus home gardens can serve as nutritional gardens for human needs. The paper reviews the available literature on home gardens and wild edible plant nutrient composition and examines the complex question of which of the many wild edible plants available should be selected as candidate crops for the future. It also highlights the need for standardization in analysis of neglected and underutilized food analysis.

Keywords: Edible wild plants, home gardens, enhanced health, income generation

Home gardens complement smallholder food production in many developing countries. In tropical and subtropical regions especially, home gardens can provide a year-round supply of many food items that may not be available in local markets or, if available, may not be affordable. The immediate accessibility of food produced in home gardens and the gardens' capacity to produce a wide range of edible plants makes them a profoundly important investment for creating food security. In Nepal, for example, "An interview with the farmers of Kholagaun in Tanahun has reported that 40 percent of the total food is contributed by the wild sources" (Gautam *et al.* 2004). So the selection of wild species and their transplanting and domestication increases the variety of foods available to families. This also improves nutritional status, conserves agrobiodiversity (Engels 2002; Schippers 2001) and provides a means for guaranteeing ready access to species which are becoming either scarcer locally or are no longer available and require time-consuming trips to gather as a result of the destruction of their traditional wild habitats through environmental degradation, agro-industrialization or urbanization.

Home gardens therefore provide sites to cultivate and domesticate valuable crops for the future through the transplanting of micronutrient-rich, neglected and underutilized species from their wild habitats.

Although transplanting and domestication of wild species has unquestionably been done, since the beginning of the Agricultural Revolution there has been little documentation of this, at least in English language scientific literature. The most comprehensive report is the study by Gautam *et al.* (2009) for Nepal. Several other papers, such as Moreno-Black *et al.* (1996), Moreno-Black and Somnasang (2000), Price (1997), Ogoye-Ndegwa and Aagaard-Hansen (2003) and Azurdia and Leiva (2004) briefly note this in northeastern Thailand, Kenya and Guatemala respectively, but provide no elaboration.

The significance of and value in transplanting wild food species rests in the fact that many are rich sources of micronutrients. Micronutrients are required for human well-being but their consumption has decreased to dangerously low levels owing to the shift

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away from traditional diets to mass-produced Western foods. An alarming effect of globalization is its impact on diet. Although the diets of numerous cultures historically have had some nutrient deficiencies owing to reliance on primary staples with limited nutrient content such as rice, the steadily increasing dependence throughout the economically-developing world on nutritionally-inadequate, highly refined, fast/convenience foods over the past three or four decades has aggravated such historical dietary deficiencies or generated them; this has caused an unprecedented epidemic of non-communicable diseases such as anaemia, coronary degeneration, diabetes, goiter and infant and childhood blindness, resulting in heretofore unimagined deterioration in human health and well-being in many parts of the world (Johns 2003; Kuhnlein 1996; WHO 2002).

A simple and inexpensive solution for improving the nutritional health of affected populations, particularly in the rural areas of developing nations, is to promote the consumption of micronutrient-rich neglected and underutilized species (NUS) of indigenous wild edible plants (IWFPs), which are potential crops for the future. Gautam *et al* . (2004) describe this succinctly: "Considering the problems discussed earlier, home garden can serve as nutritional garden for family needs. A diversified home garden with at least eight to twelve diverse species can contribute nutritional requirement, particularly, leafy vegetable rich in iron, vitamin A, vitamin C, vegetable protein, and dietary fiber. Moreover, food grown at home garden is culturally preferred and valued for safe and fresh for home consumption. Home gardening can be combined with neglected and underutilised traditional crops for providing variety of food and fruits." The same perception is held by a Native North American group: " Even when households have access to commercially grown fruits and vegetables, as on the Hopi Indian Reservation in northern Arizona, many of those gardeners told us that they prefer produce from their own gardens because it is fresh, flavourful and not contaminated with agrochemicals" (Soleri and Cleveland 1992). Home nutrition gardens have also been innovated in Zimbabwe (Brazier n.d.).

Seemingly, then, the most logical way to start the re-introduction of wild edible plants into contemporary diets is to grow them in home gardens. This is being done in Nepal: "In many home gardens across the sites, a large number of wild species have been domesticated for their unique use-values such as medicinal properties, vegetables during dry seasons, etc." (Gautam *et al.* 2004).

Research shows that indigenous wild edible plants can be rich sources of micronutrients − vitamins and minerals − that are destroyed when the fresh plants are subject to industrial processing. Restoring these crucially important substances to daily diets is the ideal way to offset the destructive consequences of consuming few, if any, fresh fruits and vegetables and large amounts of refined carbohydrates and hydrogenated and/or animal fats which have caused the epidemic of often fatal, non-communicable diseases noted above (Grivetti and Ogle 2000; Ogle *et al.* 2001).

Having presented perspectives in support of transplanting and domesticating micronutrient-rich indigenous wild edible plants into home gardens, there is the additional complex question of which of these many edible plants, growing in various ecozones, should be selected as candidate crops for the future.

The primary criterion for selecting and evaluating NUS as potential crops for the future is their nutrient value; therefore compositional analysis is the crucial next requirement in identifying crops for future research. The significance of such analysis has been emphasized by several writers such as Altschul (1968), Grivetti (1981) and Longhurst (1987) with regard to wild edible plants in general. Such analysis is also necessary to identify the presence and degree of possible toxic compounds.

Although only a small percentage of documented famine food plants has been chemically analysed, some have shown unusually high values for a variety of essential nutrients. These examples provide further indication of genetic resources to be investigated for the identification of staple crops for the future, among heretofore neglected and underutilized species.

This research focus, in the context of NUS, has been on famine food plants so the following examples are drawn from the literature on this group of plants. Some of the earliest plant nutrient content analyses were done, over 100 years ago, for Indian subcontinent species by King (1869), a surgeon attached to the Marwar Political Agency who published notes on famine foods used in the Jodhpur area of India. Almost a decade later, another physician, Shortt (1878), recorded famine plants used in the Madras region of southern India; this was followed by Gammie (1900) on famine food plants eaten in the Bombay Presidency. Four years later, Hooper (1904) published his compositional analysis of famine food plants and in the same year two British physicians, Paton and Dunlop (1904), added similar data. At that time, however, the field of analytical chemistry was still in its infancy, so these old data require confirmation.

Regarding NUS nutritional analysis, there are several crucial, consistently overlooked factors in reports for both famine as well as staple food plant species that must be understood before undertaking any analytical work: (1) the plant samples' scientific identities must be correct; (2) the accuracy of previously published analytical results must always be questioned because such data are often 'recycled', i.e. they are taken from already published literature and used as baseline comparisons, which rarely include detailed information regarding the analytical procedures followed. The result is an unavoidable lack of consistency due to the absence of analytical and methodological standardization. This is a very serious problem. The absence of standardization can only be resolved by following proven procedures and techniques. In this regard, the monograph by Garfield and Southgate (2003) is considered the authority for all laboratories doing this work. Equally important is the *sine qua non* use of certified reference materials as the baseline for standardization of laboratory measurements in order to eliminate any question about the accuracy and reliability of the analytical results. Many published studies also do not specify the edible portion or preparation of the food sample prior to analysis; contemporary plant chemical analyses must document these factors, both of which can affect the analysed concentration of particular nutrients in a food. A review of deficits in food compositional analysis procedures was written by McBurney (2004) and is also recommended to scientists involved in this work.

To encourage and promote the transplanting and cultivation of micronutrient-rich IWFPs in home gardens the author has developed a workshop for rural women in economically-developing areas. The workshop is structured into three sections: (1) a nutrition education component, to help participants understand the importance of micronutrients and how IWFPs can make their families healthier; (2) guidelines for establishing small businesses to sell IWFPs in local markets; and (3) information on possible sources of funds to establish such businesses, using microcredit financing as well as creating cooperatives, for which Thailand has a well-developed infrastructure.

In this regard, an observation by Somnasang and Moreno-Black (2000) is encouraging: "When asked how urban people view wild food, the villagers were of the opinion that town people like nondomesticated food and are often eager to purchase these items for ingredients in specific dishes, or as snacks. Villagers believed that wild food has a high market value, sells better than domesticated food and thus brings them a better earnings than domesticated food".

For establishing small businesses, the *Handbook on small enterprises for hill tribe people in_Thailand* (Pongwat *et al.* 2003) is an excellent manual that can be adapted cross-culturally.

The most important part of operating a small business is record-keeping to provide information about business expenses and to calculate profit and loss; it is also indispensable when applying for start-up loans. An invaluable resource in this context is the manual by Murcia (1985), written especially for audiences who are only minimally or non-literate.

Two excellent manuals for the nutrition education component are FAO (n.d.) for home gardens and Brazier (n.d.) for extension workers in Zimbabwe.

For developing cooperatives, the FAO kit by Premchander and Polman (2004) is also recommended.

Finally two fine examples from Thailand: the first, *Social marketing. Vitamin a-rich foods in Thailand. A model nutrition communication for behavior change process* (Smitasiri *et al.* 1993), is an outstanding model for social change in the context of public health-related nutrition education. It contains all the necessary guidelines for creating community receptiveness for the transplanting of micronutrient-rich wild edible plants for cultivation in home gardens and for sale in local markets throughout the economically-developing world. The article by Attig *et al.* (1991) on the role of home gardens as a source for micronutrients is also highly recommended. The second example by Price (n.d.) is multidisciplinary in nature and notable for its interuniversity collaboration. The goal is "To determine the contribution, of 'wild' vegetables, fruit and mushrooms in the farming environment for health, nutrition and income among rural households and the sustainability of the food resource. In particular, the relative value of the wild plant foods for the poor in the context of their overall diet and income is to be determined". (Price n.d.)

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Local wild plants from the Thar Desert for improved health and food security

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The Thar Desert of western India has provided several ‘miracle’ plants of immense food and medicinal value. Native communities have adopted a unique indigenous knowledge system for environmental conservation and sustainable management of these natural resources for food security. A good example is Panchkutta, *a preparation of mixed fruits from four very common native trees namely Ker* (Capparis decidua), *Kumat* (Acacia senegal), *Khejri* (Prosopis cineraria), *Gonda* (Cardia Myxa) *and an annual creeper Kachri* (Cucumis callosus)*; the combination is known as* Panchkutta. *The fruits are sun-dried and then different proportions are mixed for* Panchkutta *preparation. This paper presents a summary of the properties of* Panchkutta, *its ingredients and traditional processing methods and use.* Panchkutta *is a readily available dish and source of nutrients in every village of southern Rajasthan.*

Keywords: Thar Desert, indigenous knowledge, *Panchkutta*, medicinal value, processing methods

Introduction

The Thar Desert of western India is the most densely populated hot desert in the world. It lies between $24^{0}40'$ to $30^{0}12'$ north latitudes and $69^{0}3'$ to $76^{0}0'$ east longitudes, covering an area of 210 016 square kilometres or about 64.1 percent of Rajasthan State. Traditional knowledge, coupled with local culture and religion has played a major role in the development and preservation of the Thar Desert’s ecosystem (Bhandari 1978). Communities have evolved strategies to live in this most hostile environment. The rural livelihood knowledge system has been a key feature of Thar Desert communities since antiquity. It reflects time-tested knowledge with a proven track record of sustainability especially during natural events like drought and famines. These communities can sustainably manage local biodiversity without harming the desert ecosystem. Moreover, indigenous knowledge can also be used to fulfill socio-economic needs and conserve biodiversity. Local communities have long had a significant interdependence with the environments in which they live.

A number of fruiting trees, shrubs and annual creepers can grow naturally in the desert. Most of the fruits and vegetables of the arid zone are available for a short duration only, hence a very little of the total produce is utilized efficiently and the rest is wasted due to limited processing capacity. Native communities have a unique indigenous knowledge system for environmental conservation and sustainable management of these natural resources for food security. The system relies on preparation of processed produce by mixing dried fruits of four very common trees namely Ker (*Capparis decidua*), Kumat (*Acacia senegal*), Khejri (*Prosopis cineraria*), Gonda (*Cardia Myxa*) and an annual creeper Kachri (*Cucumis callosus*); the combination is called *Panchkutta*. Owing to

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intense sunshine during most of the year, sun-drying of these commodities is very common. This paper presents a summary of the properties of *Panchkutta*, its ingredients, traditional processing methods and use.

Study areas

The study was carried out in Roopawas, Dhamli, Jadan, Kharia, Ketawas and Sodawas villages of Pali District where natural resources were abundant and many people were involved in *Panchkutta* preparation. Approximately 240 households were surveyed using questionnaires, in-depth semi-structured interviews and participatory rural appraisal techniques including focus group discussion; available literature was also reviewed. Information gathered from the survey was triangulated.

Results

*Ker {*Capparis decidua *(Forsk), Edgew}*

Ker grows well on sand dunes and produces flowers and fruits. Ker fruits at four to five years of age. The fruits are harvested after seven to ten days of fruit setting (5-8 millimetre diameter during March to April). The immature fruits are used for preparation of pickles and so forth after processing. The ripe fruits are sweet but acrid in taste and thus not used as table fruit but are enjoyed by children and rural tribes. The flower buds are cooked as pot-herbs .The fruits are a rich source of protein and minerals. The unripe fruits are also a rich source of proteins (8.6 percent) and vitamin C (8 milligrams/100 grams pulp).

Processing for value-added products: Because of their acrid taste, the fruits are not utilized directly but only after processing. The tender fruits are harvested and the stalks are removed. The fruits are then stored in an earthen pot by mixing curd (250 grams) and salt (50 grams) per kilogram of fruit; water is added till the fruits are properly embedded and then the pot is kept in a sunny place after closing the lid. Water is drained after four days and the process is repeated three to four times till the fruits have a flat and salty taste. The processed fruits can be utilized directly for preparation of pickles etc or can be dried for off-season utilization. The recovery rate is about one-fourth, i.e. 1 kilogram of fresh immature fruit yields about 200-240 grams of processed dried fruit. Based on size, three relative grades of processed Ker are available in the market − big, medium and small. The smaller fruits are more tender and of better quality than the bigger fruits. The processed fruits are stored either in pots or in plastic containers while processed dried fruits are stored in polyethylene bags.

Food: The flower buds and immature green fruits of Ker are pickled, cooked and consumed as vegetable substitutes. They are also cooked as ‘vegetables’ with the fruits of *Prosopis cineraria* (Sangri) and seeds of *Acacia senegal* (Kumat).

Oil: The seeds of *C. decidua* contain 20.3 percent oil of high quality. The oil consists of 68.6 percent unsaturated fatty acids and 31.4 percent saturated fatty acids. The oil is edible after processing.

Medicinal uses: Local communities believe that *C. decidua* has the following medicinal properties:

- Stomach ache: Soak fruits in saline water for ten days, dry and make a powder. Take a spoonful orally twice a day.
- Diabetes: Take two spoonful of the powder of the de-seeded fruit orally.

- Constipation: Soak fruits overnight. Dry them and grind into a fine powder. Take a spoonful of the powder orally every morning.
- Toothache: Tender shoots and leaves when chewed relieve toothache.
- Rheumatism: Cook the chopped fruit (3 kilograms) along with jaggery (500 grams) in ghee (500 grams). Take the preparation (30 grams) twice a day for a month.
- Eczema: Make a paste from the bark of Ker and leaves of Mamejava (*Enicostema littorale* Bl.). Mix in equal quantity. Apply the paste to the infected area.

Paste made from fresh young leaves and tender shoots is applied to burns and inflammations, whereas dried and powdered leaves are used as antidotes against poison and as a cure for joint problems.

*Khejri (*Prosopis cineraria*)*

Khejri also known as Kalp Taru is another plant species found in theThar Desert. The tender pods, eaten green or dried after boiling, are called Sangri locally and used in the preparation of curries and pickles. When ripe the pods are sweet and contain 9-14 percent crude protein, 6-16 percent sugar, 1.0- 3.4 percent reducing sugars and 45-55 percent carbohydrate (Jindal *et al*. 2000). The pods are also used as feed for animals. The tree provides excellent fuelwood and charcoal. The wood is hard and reasonably durable; it has a variety of uses for house building and making utensils. The multiple uses of Khejri are shown in Table 1.

Table 1. Multiple uses of *khejri*

Plant part	Uses
Main trunk	Quality timber for furniture and implements
Lopped branches	Dried branches as fuelwood and fencing material
Leaves	Stall feed for livestock
Dried green pods	Green and dehydrated pods as 'vegetable' constituents of *Panchkutta*
Mature pods	Cattle feed
Dried ripe pods	Fresh consumption on a limited scale, can be mixed with wheat flour for making chapattis, preparation of cookies, cattle feed
Inflorescence	Blood purifier, for skin diseases, to safeguard against miscarriage
Stem bark	Tanning; treatment for boils, leprosy, dysentery, bronchitis, asthma, leucoderma, piles, tumours and scorpion sting/snake bite
Root	Root bark for tanning, thick roots for agricultural implements, thin roots as fuelwood
Gum	Postnatal use, glue

The leaves are considered as excellent fodder. The green leaves contain 14-18 percent crude protein, 13-22 percent crude fibre, about 6 percent ash, 44-59 percent nitrogen-free extract, 0.28-0.9 percent phosphorus and 1.5-2.7 percent calcium.

Harvesting and yield: Usually, the Khejri plant flowers during spring, February to March, and the tender pods are ready for harvesting in April to May. Although flowering and fruiting are influenced by agro-ecological conditions and management practices, in general pods are ready for harvesting within 20 days of fruit setting. The green tender pods at the papery soft stage can be harvested for Sangri purposes while the ripe pods can be harvested for preparation of cookies. The dried ripe pods are called Khokha. A fully grown (30 to 50 years) and unlopped tree produces about 5 kilograms of air-dried pods and about 2 kilograms of seeds (Nath *et al*. 1993). The pods are graded into different stages according to size and maturity for further processing. The tender pods fetch better prices in the market than mid-mature pods but both can be utilized as fresh 'vegetables'.

Processing for value-added products: Pod drying is commonly practised by communities in western Rajasthan. The pods are washed in water thoroughly in order to remove dust and other inert material adhering to the surface. Pods are blanched in a 2 percent salt solution then sun-dried. Dehydrated pods are packed in gunny bags, and in polyethylene bags can be stored for more than 12 months without deterioration.

Societal aspects: The *Khejri* plant provides food and fodder for millions of poor people in the desert. Besides its multiple utility, it has economic, cultural and socio-religious value. In Rajasthan, cutting of Khejri is strictly prohibited and damaging the tree is considered sacriligious.

*Kumat (*Acacia senegal*)*

Acacia Senegal, locally known as Kumat, is a multipurpose tree grown primarily for gum but plays a secondary role in agricultural systems, restoring soil fertility, stabilizing sand dunes and providing fuel and fodder. Dried and preserved seeds are palatable and commonly used by people as a 'vegetable' as it is a good source of protein.

The foliage and pods are browsed by sheep, goats and camels. Leaves contain 10-13 percent digestible protein and 0.12-0.15 percent phosphorus, while the pods contain 15 percent digestible protein and 0.12-0.14 percent phosphorus. Seeds contain fat, which is used both for medicine and for soap-making. Leaves and gum are used to treat gastritis disorders, haemorrhage, ophthalmia, colds, diarrhoea, as an emollient and an astringent; the gum is considered an aphrodisiac. The socio-economic importance of Kumat for the production and trade of Gum Arabic as well as use of its leaves pods as forage and its ecological requirements are well recognized (Chandra *et al*. 1994).

Harvesting and yield: Fruits (pods) ripen at the end of September to November. At the time of maturity, some of the pods start to split and the colour turns from green to yellowish or brown; after harvesting of pods from trees, seeds can be separated. On average 17 Q seeds can be obtained from one hectare of plantation. Another important product of this tree is Gum Arabic. The best period for gum tapping is when the trees start shedding their leaves after turning a yellowish colour, i.e. usually when the winter season sets in, which coincides after mid-October or early November. Gum Arabic exudes from the duct of the inner bark; it is also tapped in the hot season (May to June) when the trees are stressed.

Processing for value-added products: Its seeds are used for preparing *Panchkutta* and curry or can be fried and salted to improve taste. Seeds are dried in Rajasthan especially by tribal people for subsequent use as 'vegetables' in the off season. They are dried after blanching with saltwater for a few minutes. For processing, fully ripe pods are selected followed by extraction of seeds and blanching in a 3.0 percent salt solution with dipping of seeds in the same salt concentration for eight hours. Water is drained and seeds are dried in the shade and packed in polyethylene bags. These seeds can be stored safely for up to six months at room temperature. Polyethylene bags of dried seeds are sold in the market as a mixture for *Panchkutta* and otherwise.

*Lasoda (*Cordia myxa*)*

Lasoda (*Cordia* spp.), also known as 'the cherry of the desert', owing to its higher productivity, suitability to adverse soil and climate conditions and high processing value, is now becoming popular as a monoculture as well as in agroforestry systems in arid and semi-arid regions (Chandra *et al*. 1992). Flowering takes place from March to May with new leaves. In Rajasthan, flowering occurs in March to April. Young plants produce 5-10 kilograms of green fruit while a developed plant yields nearly 50 kilograms of fruit. Lasoda trees are also known for their shade during the hot summer; it is planted around fields or orchards as windbreaks to protect orchards from hot and cold winds and also to provide additional income. Lac insects can also be reared on Lasoda plants. Twigs are used as fuelwood. Fibre obtained from bark is used for caulking boats. The Lasoda kernels are used for curing ringworm.

Fruit: The tender fruits are mostly used as a 'vegetable'. They are also dried for consumption in the off season. Half-ripe fruits make a tasty broth. Mucilage obtained from half-ripe fruit can even be used as an alternative to paper glue. Fruits can make an excellent pickle that is effective against indigestion. Ripe fruits are eaten fresh and used for preparing liquor. Ripe fruits are full of vitamins and regular use supplements hair growth and prevents baldness. Fruits have profound medicinal value and are considered to have antihelmentic, diuretic, demulcent and expectorant properties.

Leaves: Leaves are used as fodder for goats and cattle during famine and contain about 12-16 percent crude protein and 16-27 percent crude fibre. Leaves are also used for preparation of eating vessels and for wrapping cigarettes. Leaf preparations of several species of *Cordia* are used in traditional medicine as remedies for osteoarthricular disease.

Processing for value-added products: Tender fruits cannot be stored for long periods at room temperature as they turn yellow and become unsuitable for consumption. They require cleaning, grading and blanching for consumption purposes. The fruits are blanched in solution containing NaCl (1 percent) + sugar (1 percent) at 100°C for eight to ten minutes followed by sudden cooling in tap water and dipping in 0.2 percent KMS for 30 minutes. In homes, fruits are generally blanched with 1 percent NaCl solution. The destoning of fruits is also required. The destoned pulpy halves of the fruits are either sun-dried or put in mechanical driers. The dried pieces are packed in polyethylene bags and can be used for cooking after rehydration.

*Kachri (*Cucumis callosus*)*

Kachri belongs to the Cucurbitaceous family and grows throughout Western Rajasthan. It is extremely drought-resistant and its roots go deep in search of water (Chaudhary 2004). Thus it survives naturally in water-deficient areas. It grows naturally on common lands and pastures during the rainy season in Rajasthan and its fruits are very sour and acidic. Hence it is used as one of the choicest 'vegetables' in combination with others. As it is produced in bulk during monsoons, it is traditionally preserved by drying. It is dried by cutting the fruits into thin slices and boiling in water for three to four minutes before drying. Other drying methods include peeling the whole fruit, boiling in water for three to five minutes and then drying in open sun for two days.

Kachri powder is used as souring agent along with other spices to make a multispice and is also used as a mouth freshener. Powder is used for treating stomach pain, gas, nausea, vomiting, constipation and diarrhoea. Indigenous people use Kachri pieces soaked in whey to cure a variety of gastric and digestion problems.

Panchkutta

In desert regions only limited vegetation is available, often for a short duration only, hence people of the region have developed different survival strategies and identified food crops which can survive harsh conditions and improve health. *Panchkutta* is a unique example of utilizing all available food resources with the aim of ensuring year-round nutritional security and making use of some of the ingredients which otherwise are non-palatable. The proportion in which each ingredient is mixed and hammer-milled to a coarse mixture has evolved over the ages. Table 2 lists the common proportions of different ingredients. Lasoda and Ker have an acrid taste, whereas seeds of Kumat have distinct flavour but an unacceptable taste; however when they are mixed with Khejri and Kachri the mixture is relished by local people. It is important to note that Kumat is rich in protein and fat, Kachri is rich in fat and minerals, Khejri and Lasoda are good sources of fibre, and Kachri and Ker are good sources of carbohydrate; their unique combination makes *Panchkutta* a balanced dish. Moreover each ingredient has its own medicinal value, thus when taken in a mixture this also provides health benefits.

Table 2. Approximate composition of Kachri, Ker, Khejri, Lasoda, Kumat and *Panchkutta* (grams/100 grams)

Nutrient	Kachri	Ker	Khejri	Lasoda	Kumat	*Panchkutta*
Moisture	8.3	10.9	6.7	9.9	10.5	8.7
Protein	2.2	12.4	17.1	9.3	33.3	16.0
Fat	10.0	5.8	1.7	5.1	9.1	5.6
Ash	11.4	5.3	4.5	4.1	4.5	5.6
Fibre	9.5	12.4	22.5	24.7	10.3	17.6
Carbohydrate	58.5	53.2	47.5	46.9	32.3	46.5
Sources	Goyal and Sharma (2008)			Ali (2011); Chaudhary (2004)	Banerjee *et al.* (1988); Chaudhary (2004)	

Conclusion

The vegetation in deserts is a unique blend of perennial grasses, hardy shrubs and scattered small trees. These perennial systems are the lifeline of the desert and sustain humans and livestock, even during drought or near famine situations. Such vegetation is dominant in hot arid ecosystems and adapted to the harsh climates of arid and hyper-arid regions. It is a primary source of food and fodder for the rural masses in areas with low tree cover and has the potential to provide products useful to local people as well as industry. The local rural population in various extreme environments has identified many plants since time immemorial and *Panchkutta* is a unique product of identified desert plants that is rich in proteins, carbohydrates and all essential nutrients. It can be stored for a long time and consumed at any time of year. Apart from its role as food it has many medicinal properties.

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Edible wild plants and rural village development in Noto Peninsula, Japan

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Edible wild plants have been widely used as important food sources in mountainous villages in Japan. Consequently,traditional knowledge relevant to cooking and preservation has been developed in each region. This paper reviews the current situation of edible wild plant utilization in Japan, followed by personal interviews with local stakeholders in a remote area in Noto Peninsula to discuss the challenges of natural resource utilization under current socio-economic situations. Less than ten species on average were harvested by local residents. Local traditional knowledge is threatened by declining demographics and ageing in rural Japan. Edible wild plant populations have decreased due to forest plantation and rural infrastructural construction. Recently, using edible wild plants has been proposed as one rural revitalization strategy. However, initiatives to cultivate edible wild plants for the central markets in megacities and to attract tourists have rarely been successful. Interviews with local stakeholders in Noto Peninsula also revealed that it was difficult to sell fresh edible wild plants due to long distances from big cities. Non-wood forest products were common in the past. It was concluded that edible wild plants should not only be considered as a food resource but also as traditional cultural heritage. The significance and value of local food and local cuisine should be re-evaluated. The rural revitalization initiative will never be successful without recognition of local culture. Natural resource utilization and management systems should be rebuilt to benefit local residents as well as to enhance the well-being of urban residents.

Keywords: Traditional knowledge, forest management, rural development, traditional dietary culture, ecosystem services, Japan

Introduction

Indigenous knowledge in developing countries has aroused the interest of many researchers in the past decades. Traditional ecological knowledge also exists widely in Europe (Kiene 2006) and Japan (Cetinkaya 2009). While traditional knowledge in Japan, in particular, is relevant to the food and health sectors it has received very little attention by academics.

Edible wild plants are usually called ‘sansai’ in Japanese. Sansai literally means ‘mountain vegetables’. Originally this term referred to edible wild plants and fungi that grew naturally and were harvested in the wild. Sansai were important food resources in the frigid north of Japan in the past. Local communities developed preservation methods including pickling, salting and drying of edible wild plants to be used throughout the

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year. Recently, rural regions have been confronting dramatic socio-economic transformation, such as a sharp decrease in the population demographic and ageing. Around 60 percent of the land is covered with forest, while only 3 percent of the population still lives in mountainous villages.

The habitats of wild edible plants and populations have been diminishing due to rapid urbanization, engineering and forest plantation projects. A survey in mountainous villages of Iwate Prefecture reported that harvests of edible wild plants and mushrooms decreased after 1985 following the expansion of plantations in state-owned forest as well as private forest (Saito 2006). The underutilization of forest resources that had close interactions with traditional activities of rural people in the past, also known as 'Satoyama' in Japanese, has resulted in a decrease in the production of wild edible plants (Saito 2006).

Satoyama is practised in secondary forests, agricultural lands, irrigation ponds, grassland as well as human settlements (Duraiappah *et al.* 2012). Satoyama landscapes have been developed through historical interaction between humans and ecosystems. Numerous efforts have been made to re-introduce Satoyama landscapes, mainly through biological approaches (Washitani 2001). However, human interactions with nature receive scant attention in academic studies or policy-making processes. The effective maintenance and promotion of traditional knowledge are crucial to contribute to the sustainable development of local communities (Cetinkaya 2009).

The focus of this paper is on the significance of edible wild plants as part of traditional dietary culture in Japan, their current utilization and some new trends as a rural development strategy initiative. Relevant literature was reviewed to grasp the general situation of edible wild plant utilization in Japan. Interviews with stakeholders (farmers, forest owners and local policy-makers) were then conducted to clarify traditional knowledge and current utilization of edible wild plants. To achieve dynamic conservation of local resources, the Globally Important Agricultural Heritage Systems (GIAHS) programme started a pilot site, Satoyama Satoumi Landscape in Noto Region, in 2011 in Japan. Thus, Noto Peninsula (Figure 1) is a suitable survey site for local knowledge and new initiatives for natural resource utilization. Interviews were conducted during March to May 2012.

Traditional dietary culture

Due to diverse geographical and cultural factors, local communities have developed their own specific preservation and cooking methods. Edible wild plants in Japan have been estimated at between 1 000 species (Miyazawa and Tanaka 1948) and 2 000 species (Sugiura 2007). However, only around 25 species are actually utilized in each area (Sugiura 2007).

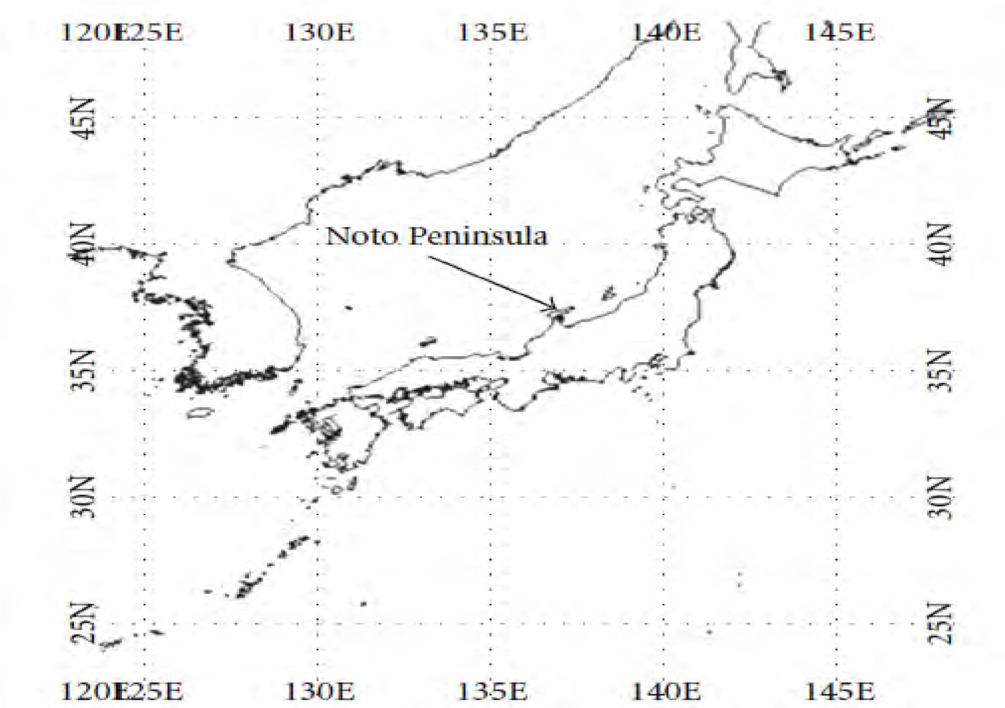

Figure 1. Location of Noto Peninsula

Recently, a field survey reported that local people harvested less than ten species of edible wild plants or mushrooms on average (Saito 2005, 2006; Mastuura 2011).

In Noto Peninsula there is a plethora of edible wild plants, estimated at approximately 200 species (Chen and Qiu 2012). Around 184 species belonging to 67 families can be used as food or as medicine. Among them, around 176 species belonging to 65 families are edible; around 60 species belonging to 36 families can be used as medicine. Almost all parts of the plants can be used, including the sprouts, flowers, fruits, seeds, soft stems and roots.

Provisioning of edible wild plants as food and otherwise in the satoyama ecosystem should be emphasized (Matsuura 2011). Edible wild plants are highly valued by residents as local seasonal food (Matsuura 2011; Chen and Qiu 2012).

In the past, relevant knowledge of edible wild plants was passed down from generation to generation (Saito 2005). An informant, Mr Yoneda, who was born in the Noto Region, indicated that his knowledge of edible plant species and their habitats was acquired by following his grandfather into the mountains to pick plants and mushrooms. However, the transmission of traditional knowledge related to edible wild plant utilization among family members has been upset by mortality in ageing populations and migration of the young to urban areas. It has been concluded that the younger generation should be educated on how to pick and cook edible wild plants in order to pass down this local knowledge to descendants (Sugiura 2007).

Edible wild pl ant h arvesting for re creation and the mountainous village development strategy

The demand for edible wild plants has been increasing as local and natural food (Japanese Forestry Agency 2005). Accordingly, local initiatives to utilize edible wild plants for mountainous village development have been started in each region in Japan via pick-your-own vegetable farms and cultivating edible wild plants for supermarkets in cities (Sugiura 2002a).

However, only a few cases have been successful (Sugiura 2002a). As edible wild plants grow naturally, securing a stable harvest for supermarket supply is difficult. Indigenous knowledge on them varies regionally, which hinders demand and profitability for supermarkets in cities (Sugiura and Uchiyama 1997).

Most wild edible plants contain an alkaloid that differentiates their taste from the more acceptable cultivated vegetables. Research is being conducted to remove the alkaloid for greater palatibility. A new variety of bracken fern root (*Pteridium aquilinum*) without plant alkaloid has been produced and sold at the Farmers' Market and pick-your-own vegetable farms (Ōkubo 1998).

Two edible wild plant farmers in Noto Peninsula were interviewed. Mr Shirasaka from Katsuradani Village started to cultivate around 0.3 hectares of Warabi (*Pteridium aquilinum*) and Seri (*Oenanthe javanica*) ten years ago. He said that the local Farmer's Market can only sell a small amount of cultivated wild plants. He also sent his produce to the central market in Kanazawa City last year.

Mr Kondou from Anamizu Town opened a Warabi farm three years ago and established the Wild Edible Plant Development Group with another two Warabi farmers. The Warabi farm was planned to be a pick-your-own vegetable venture, however only 20 visitors came last year. He said that he plans to pickle Warabi for retail to restaurants in Kyoto for the whole year.

Both farmers are confronted by small market scale and the long distance from Noto Peninsula to megacities such as Tokyo, Ōsaka and Kyoto. Mr Kondou believed that his new business will grow with more tourist influx to Noto Peninsula.

Edible wild plants are also supplied to inns and restaurants that cater to tourists. A restaurant that only serves local cuisine, managed by the Sakamoto Family in Suzu city, is a rare example of success in Noto Peninsula. The family has a large old house that was built around 80 years ago with a spacious garden and trees that are several hundred years old. Seven years ago, the family opened a restaurant in their house. In spring and autumn, the main dishes are wild vegetables and mushrooms that are harvested locally. In summer and winter, preserved wild vegetables are served as side-dishes. Mrs Nobuko Sakamoto said that she hired about five elderly women to help with harvesting and preserving edible plants because they have rich experience with wild plants. They also help with household chores. The business benefits from local cooperation and knowledgeable local residents, but also contributes to the local economy in this extremely remote region. Mrs Sakamoto said that they will open reasonably priced guest rooms this summer.

Mrs Sakamoto attributes the venture's success to the absence of local food restaurants. A local expert on edible wild plants, Mrs Taniguchi, agreed. The lack of local food restaurants in Noto Peninsula suggests that the local residents engaged in the tourist industry are unaware of the attraction of local food and local resources.

Edible wild plants and forest ownership

Non-wood forest products, such as edible wild plants and mushroom, were commonly picked by local communities in the past in Japan (Inoue 1997; Umezaki 2001) and other Asian countries. The environment was under the co-management and co-utilization of local communities. Even today, local residents have relatively free access to edible wild plant harvesting for self-consumption.

Owing to modern advances in transportation it is much easier for urban residents to access forests and edible wild plant picking has become a recreational activity in Japan; however conflicts between forest owners and pickers have been reported (Japanese Forestry Agency 2005), particularly for valuable species such as the matsutake mushroom. Local residents claim that commercial pickers tend to clear wild plants and impact natural generation. In contrast, villagers have their own harvest rules for sustainable resource management. For plants with roots, a respondent, Mr Shirosaka, indicated that villagers used to pick only one-fourth of a cluster of *Allium victorialis* each year. However, outsiders might remove the whole cluster.

In order to prevent outsiders from pillaging forest resources, access to private forests is being restricted. It is possible for people to pick edible wild plants on public land land. However, inadequate mapping of public land, insufficient knowledge of wild edible plant habitats as well as potential attacks by wild animals are hindering recreational wild plant picking by urban residents. It was reported that urban residents from Kyoto did not participate in wild plant harvesting because they did not know where wild plant habitats could be found (Saito 2005). Attacks by wild bears and boar have also been reported. A strategy for freer access to forests and better information for people to harvest wild edible wild plants as a recreational activity is still in the pipeline.

Conclusion

Historically, edible wild plants have been important food resources in mountainous villages in Japan. Consequently, considerable indigenous knowledge on their collection and consumption has been accumulated in each region. However, an inventory of existing edible wild plants nationwide is sparse and this is urgently needed, especially for endangered species. Traditional cooking and preservation techniques should also be recorded.

Due to the sharp decrease of Japan's rural population, transfer of indigenous knowledge relevant to edible wild plants to the younger generation is threatened. This needs to be addressed (Dweba, and Mearns 2011).

Using edible wild plants has been proposed as part of the rural revitalization strategy with a focus on recreational collection by urban residents. However, initiatives to cultivate wild plants for the central markets in megacities and to attract tourists have not been very successful to date (Sugiura 2002a). It is also difficult to sell fresh edible wild plants due to long distances from cities. Although wild edible plants are harvested and eaten by local residents, they rarely feature on restaurant menus. The significance and value of local food and local cuisine should be re-evaluated. The rural revitalization initiative will never be successful without recognition of local culture.

Conflicts between local villagers and outsiders who harvest non-wood forest products need to be resolved.

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Indigenous food crops of the Aetas tribe in the Philippines and their traditional methods of food preparation

Arturo M. Alegado[1] and Romualdo B. De Guzman, Jr.[1]

The study aimed to gather benchmark information on indigenous food crops gathered by the Aetas aboriginal tribe in Bataan forests of the Philippines. It focused on the identification, classification and documentation of plant species considered as food sources by the Aetas. Processing or food preparation involving traditional cooking methods were also considered. At least 38 out of 42 plant species were identified and provided with botanical descriptions. Fifteen out of 20 traditional dishes were also identified and ingredients were documented. Twenty-one species had been depleted by illegal logging, slash-and-burn agriculture and illegal gathering while 20 remained safe because they were cultivated. It was concluded that protection, rehabilitation and conservation practices are needed to sustain local indigenous crops to complement food security thrusts in the country and elsewhere.

Keywords: Philippine Aborigines, indigenous foods, traditional food preparation

Methodology

The following criteria were deemed necessary for the study:

1. The Aetas community must be located near to a forest area, national park or community-based forest management site.
2. The community must be a gatherer of indigenous food crops.
3. The elders must be able to identify and process the indigenous crops.
4. The community must subside on indigenous food crops.
5. The community must be willing to participate in the research activities.

The most significant aspects of the data collection are elaborated below:

1. Tribal leaders and elders were interviewed about the species of food crops that they acquired from the forest. The yields and processing methods of these crops were analysed.
2. Interview data were consolidated and validated before actual identification was undertaken.
3. The different food crops were identified according to botanical classification and crop species were photographed. This was accomplished with the assistance of an Aetas guide in the bush to locate the crops.
4. A taxonomist assisted with the botanical classification.

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At least 38 out 42 species of plants were identified and provided with botanical descriptions (Table 1).

Table 1. Food crop species used by the Aetas tribe in Bataan, Philippines

Common name	Botanical name	Family name
Matang-ulang	*Phyllanthus rhamnoides* Retz	Euphorbiaceae
Alupag	*Euphorria didyma* Blanco	Sapindaceae
Ayumit	*Ficus minahasse*	Moraceae
Bunga	*Adonidia merilli* (Becc.) Becc.	Palmaceae
Limuran	*Calamus ornatus*	Palmaceae
Palasan	*Calamus maximus*	Palmaceae
Mala-uban	*Calamus microcarpa* Becc.	Palmaceae
Ditaan	*Daemonorps mollis*	Palmaceae
Bulak-manok	*Ageratum conyzoides* Linn.	Asteraceae
Pingol-bato	*Begonia nigritarum* Steud,	Begoniaceae
Takipan	*Caryota rumphiana* Ledd. Ex Martius	Palmaceae
Pako	*Athyrium esculentum*	Aspidiaceae
Gabi	*Colocasia sp.* (Linn.) Schott.	Araceae
Luyang dilaw	*Curcuma domestica*	Zingerberaceae
Kamagong	*Diospyros philippensis*	Ebenaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Binucao	*Garcinia binucao* (Blanco) Choisy	Clusiaceae
Lamio	*Dracontomelon edule* (Blanco) Skeels	Anacardiaceae
Himbabao	*Broussonetia luzonica* (Blanco) F. Vill	Moraceae
Lubi-Lubi	*Solanum nigrum* Linn.	Solanaceae
Lima-Lima	*Schefflera odorata* Blanco	Araliaceae
Tungkod-langit	*Helminthotachys zeylanica*	Ophioglossaceae
Ubi	*Dioscorea alata*	Dioscoreaceae
Kamoteng-kahoy	*Manihot esculenta* Crantz	Euphorbiaceae
Kamoteng-baging	*Ipomea batatas*	Convolulaceae
Kalot	*Dioscorea hispida*	Dioscoreaceae
Bignai	Atidesma bunius	Euphorbiaceae
Aluloy	*Gonostegia hirta*	Urticaceae
Dampali/Taraumpalit	*Sesuvium portulacastrum*	Aizoaceae
Tanlag	*Cymbopogon citrates* (DC.) Staft.	Poaceae
Bitongol	*Flacoutia ukam* Zollinger and Moritz	Flacourtiaceae
Tugi	*Diocorea esculenta* (Lour) Burkill	Dioscoreaceae
Kulitis	*Amaranthus spinosus* Linn.	Amaranthaceae
Makopa	*Syzygium samargense* (Blume) Merrill and Perry	Myrtaceae
Pahutan	*Mangifera altissima* Blanco	Anacardiaceae
Malatampui	*Syzygium zanthophyllum* (C.B. Robinson) Merrill	Myrtaceae
Datiles	*Muntigia carabola*	Flacourtiaceae
Araru	*Maranta arundinacea* Linn.	Marantaceae

Food preparation methods were also documented. Fifteen dishes and ingredients were recorded based on traditional cooking procedures (Table 2).

Table 2. Local dishes and ingredients used by the Aetas tribe in Bataan, Philippines

Dish	Ingredients
Tinutuk (Inihaw, Tag.)	Shoots of Rattan spp.
Tnuktuk	Pako
Patugong	Rice and Buho culms
Patbu	Rice, Buho culms and Hagikik leaves
Nilurok Ka Lain	Gabi leaf sheaths and leaves
Imbuu Hira	Binucao leaves and any kind of meat
Nilurok Ka Yatok/Takipan	Shoots of fish tail and Rattan spp.
Imbuu Kamoteng Baging	Sweet potato root
Imbuu Kamoteng-kahoy	Cassava root
Bulanglang Na Babayan	Himbabao leaves/flowers
Tinanglarang Suso	Tanglag/lemon grass
Inlaga In Aluloy	Aluloy fruit (fresh green)
Imbusu Ang Gagang	Pingol-bato leaves, Pako and freshwater crab
Habang Adava	Amaranth leaves, Gabi root and processed fish
Ilung (salad)	Dampalit leaves

Food crops of other economic importance are disaggregated below:

- Medicinal value: Matang-ulang, rattan, colocasia, Amorgoso, Ayumit, Bunga, Lubi-Lubi, Lima-Lima, Kamoteng-Kahoy/Cassava, Kamoteng-baging, Bignai and Tanglag.
- Biopesticide: Capsicum and Kalot.
- Construction material and furniture: Bitongol, Pahutan, rattan and Binucao.
- To prevent soil erosion or for agroforestry: Tanglag and Bignai.
- Alternative to rice: Cassava, sweet potato, Lima-lima, Ubi and Araro.

It was noted that 21 species had been depleted by illegal logging, slash-and-burn agriculture and illegal gathering while 20 remained safe because they were cultivated.

Conclusion

Based on interviews and data gathered, the researchers concluded the following:

1. The identified food crops provide relevant information on the status and economic benefits to the community in terms of food and medicinal benefits. This could serve as reference material for different studies on food security and health-related issues as well as anthropological research.
2. The chemical composition of unfamiliar species should be analysed to determine toxicity levels or nutritive value with a view to disease prevention.
3. The traditional Aetas cuisine can be disseminated to other communities to (1) preserve the culture and (2) increase awareness on preventing beneficial plants from vanishing from the forest.
4. Protection, rehabilitation and conservation practices are needed to sustain local indigenous crops to complement food security thrusts in the country and elsewhere.

Annexe 1. Two Aetas recipes

Bulanglang Na Babayan

Ingredients:

Processed fish/Bagoong, Himbabao leaves, salt and tomato


First remove the mature and undesirable leaves of freshly gathered Himbabao.


Wash the leaves thoroughly with clean water after removing the undesirable and mature leaves.


After washing the leaves, put the leaves half filled in the Buho (hollowed out bamboo stalk).


Add the juice of at least two tree tomatoes.

Add water to the leaves in the Buho. Then add ½ to 1 tablespoon of salt.

Angle the Buho above a slow-burning fire to avoid immediate roasting or overcooking.

Prevent water from overflowing by moving the Buho with a stick.

While the water is boiling, add processed fish or Bagoong for additional salting or flavour.

After a few minutes when the leaves are cooked, move the pot away from the fire to allow it to cool.


Newly cooked Bulanglang Na Babayan served on a plate.

Tinanglarang Suso in Tanlad

Ingredients:

A cup of edible snails, salt and 1 piece of Tanlad.


Put the snails in a basin with water to remove their waste.


Remove the tail ends of the snails and put them into another clean basin with water.


Take one piece of Tanlad, hold the basal portion, remove the roots and pound them thoroughly to let the sap out.


Put the snails into the Buho.


Add water and pour 3 pinches of salt into the dish.


Put the Buho at an angle and allow the dish to boil.


After a few minutes of boiling, move the Buho away from the fire and allow it to cool for a few minutes.

Then serve on plate as Tinanglarang Suso.

All photos courtesy Alegado.

Appendix

Recipes from the Philippines using indigenous vegetables as the main ingredients[1]

To enhance the promotion of indigenous vegetables, a cooking contest became one of the main activities during field days which were held in the following areas in the Philippines: Metro Manila, Cordillera Autonomous Region-Benquet, Los Baños-Laguna, La Granja-Negros Occidental and Davao-Southern Mindanao. The participants prepared their original recipes using indigenous vegetables as the main ingredients.

Talinum (waterleaf) salad

Ingredients

1 onion
1 small pack of black pepper
1 tablespoon sugar
5 tablespoons vinegar
1 tomato, ¼ kg Talinum

Good for four persons; cost PhP 28.00[2]

Procedure

1. Steam the Talinum leaves in 2 cups of boiling water for 2 minutes. Then set aside.
2. Mix/season the Talinum leaves with 5 tablespoon of vinegar, 1 tablespoon sugar and ½ tablespoon of black pepper
3. Then add the sliced tomato and onion as garnish

Dinengdeng

Ingredients

Cooking oil
1 garlic clove
1 onion
4 tablespoons of Bagoong
2 tomatoes
3 pieces Ampalaya
¼ kg Malunggay leaves
¼ kg Kulitis leaves
¼ kg Saluyot leaves
¼ kg Katuray flowers
¼ kg Himbabao
¼ kg Hebe (dried shrimps)

Good for five persons; cost PhP94.00

Procedure

1. Boil three cups of water or Hugas Bigas (optional)

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[1] Extracted from ‘Cultivation and utilization of selected indigenous vegetables in the Philippines’ by J.P. Tolentino-Garcia, this publication.
[2] US$1.00 = PhP41.8 (August 2012).

2. Add 4 tablespoons of Bagoong or fish sauce, sliced tomatoes and Hebe. Let it simmer for 1 minute.
3. Add green leafy vegetables such as Malunggay, Kulitis, Himbabao, Saluyot, Katuray and Ampalaya
4. Then simmer for 2 minutes until done and serve

Tortang Kulitis with Himbabao

Ingredients

Cooking oil
2 eggs
1 pack of breading
¼ kg Kulitis leaves
¼ kg Himbabao leaves and flowers

Good for three persons; cost PhP55.00

Procedure

1. Steam the Kulitis and Himbabao for 1 minute
2. After steaming, set aside
3. Season and add on to the breading
4. Mix with eggs and fry

Alugbati with mushrooms

Ingredients

Cooking oil
1 onion
1 garlic clove
2 tomatoes
¼ kg Hebe
¼ kg Alugbati leaves
200 g of mushrooms
¼ kg of ground pork
Salt or fish sauce

Good for four persons; cost PhP80.00

Procedure

1. Pour 3 tablespoon of cooking oil or butter into a hot sauce pan
2. Sauté garlic and onion
3. Add the ground pork until it turns brown
4. Add mushrooms
5. Season with fish sauce and simmer for 1 minute
6. Put on the Alugbati leaves and cover for 1 minute, then serve

Labong Sisig

Ingredients

Cooking oil
1 garlic clove
1 onion
200 g Hebe
5 pieces Calamansi

¼ kg ground pork
½ kg sliced bamboo shoots
250 g tofu
Salt/fish sauce
5 tablespoons of vinegar

Good for five persons; cost: PhP126.00

Procedure

1. Pour 3 tablespoons of cooking oil into a hot sauce pan. Sauté garlic and onion.
2. Add ¼ kilogram ground pork. Stir and season with 1 tablespoon of fish sauce to taste.
3. Add ½ kilogram of sliced bamboo shoots and let them simmer for 5 minutes
4. After simmering, add 5 tablespoons of vinegar and cover for 3 minutes
5. Set aside from the sauce pan. Place on a platter.
6. Add fried tofu on top.

Kulitis with tofu

Ingredients

Cooking oil
1 garlic clove
1 onion
3 tablespoons oyster sauce
¼ kg tofu
½ kg Kulitis
½ cup water
1 tablespoon salt

Procedure

1. Sauté garlic and onion in the sauce pan
2. Pour 2 tablespoon of oyster sauce in just 5 seconds. Add Kulitis
   Note: Do not overcook the Kulitis, blanch for better taste
3. Spread

Vegetables in Hacobe sauce

Ingredients

2 tablespoons cooking oil
1 tablespoon crushed garlic
1 tablespoon chopped onion
2 tablespoons chopped bell pepper
2 cups Kulitis
2 cups Alugbati
1 cups Malunggay flowers
¼ cup Talinum
100 g ground pork

Procedure

1. Sauté garlic, onion, bell pepper until golden brown
2. Add ground pork until simmering
3. Add 1 cup of water
4. Then add Alugbati, Talinum, Malunggay flowers and Kulitis until cooked
5. Season with salt and MSG to taste

Sauce

Ingredients

5 tablespoons coco honey
7-8 tablespoons coco sugar
5 tablespoons coco vinegar

Procedure

1. Sauté garlic
2. Add coco honey, coco sugar and coco vinegar
3. Boil for 2 minutes and serve

Makulay Na Gulay Sa Dahon Ng Gabi

Ingredients

½ cup Malunggay
½ cup Saluyot
½ cup Camote tops
½ cup Alugbati
½ cup Kulitis
½ cup Kangkong
½ cup Dahon Ng Sili
½ cup Dahon Ng Gabi
½ cup Katuray flowers
1 medium-sized carrot
1 can yellow corn
1 young coconut
1 matured coconut
5 red peppers
¼ kg Hebe
6 tablespoons Patis
1 cup of water
1 garlic clove
1 piece of ginger
1 onion bulb
1 tablespoon black pepper
1 tablespoon Atsuete

Cost: PhP172.00

Procedure

1. Wash all the vegetables then set aside
2. Wash Hebe then set aside
3. Extract matured coconut and measure
4. Measure all leafy vegetables and set aside
5. Mix young coconut, corn, carrots and all the spices then add salt
6. Arrange all the ingredients on the Gabi leaves (young coconut, green leafy vegetables and shrimp alternately layered)
7. Wrap the mixture with the Gabi leaves
8. Let the coco cream boil then add the wrapped vegetables until done
9. Remove from fire then allow to cool
10. Slice into half then arrange on the platter and garnish

Vegetables Kare Kare

Ingredients

5 g squash
1 g Talinum
1 g Alugbati
1 g Katuray flower
2 g string beans
2 eggplants
1 banana blossom
15 g peanut butter
1 g spinach
½ cup cooking oil
3 onion bulbs
Food colouring/Atsuete
6 cups water
1 g Saluyot

Procedure

1. Cut squash into cubes, then fry until golden brown, set aside
2. Sauté garlic, onion then add 6 cups of water and boil
3. Add banana blossom until tender
4. Add string beans and eggplant
5. When the vegetables are cooked, add peanut butter and all leafy vegetables
6. Boil until done
7. Serve hot

Luyarot express

Ingredients

Luya
Tomato
Lemon grass
Sweet pepper
Alugbati
Malunggay
Ampalaya
Salt
Gata

Total cost: PhP16.50

Procedure

1. Put spices, Ampalaya, Alugbati into the bamboo
2. Add the second extracted coconut milk, add salt to taste
3. Place over fire
4. During the boiling process, add the first coco milk extract
5. Add the remaining leafy vegetables
6. Add salt to taste
7. Serve hot with plain rice

Ginataang Gulay

Ingredients

½ kg Dabong
Coconut milk
Malunggay
Saluyot
Alugbati
Pako
Luya
Sibuyas Dahon
Kamatis
Spada sili

Total cost: Php 28.00

Vegetables Lumpia

Ingredients

2 tablespoons cooking oil
3 garlic cloves (finely chopped)
1 medium-sized onion bulb
½ cup green beans
½ cup carrots
¼ cup Pako leaves
½ cup ground peanut
Malunngay
Kulitis
Talinum
Alugbati
Kangkong
Tinangkong
Saluyot
Lumpia wrapper
½ tablespoon iodized salt
Pepper to taste
3 tablespoons water
Oil for frying

Total cost: PhP65.00

Procedure

1. In pan, heat oil then add garlic, onion until golden brown
2. Add the vegetables until almost done
3. Season with pepper and soy sauce
4. Set aside and drain excess liquid
5. Wrap with Lumpia wrapper
6. Deep fry and serve hot with vinegar

Ginatang Gulay Con Kabibi

Ingredients

½ kg shell
Malunggay
Saluyot
Ampalaya leaves
Alugbati
Kangkong
Kulitis
Katuray flowers
Spices
Gata Ng Niyog
Iodized salt

Serving: Good for 5-6 persons; total cost: PhP31.00

Molokeya (Saluyot)

Ingredients

½ kg Saluyot
¼ kg sliced chicken
1 chicken stock cube
3 garlic cloves
½ onion bulb
¼ teaspoon salt
1 teaspoon MSG
1 tablespoon cooking oil

Total cost: PhP 45.25

Procedure

1. Blend the Saluyot
2. Slice chicken into 4 quarters
3. Sauté garlic and onion
4. Add chicken and cook for 15 minutes or until tender
5. Add ½ glass of water and let it boil
6. Add the blended Saluyot , salt and MSG
7. Serve hot

Vegetable curry

Ingredients

2 cups string beans (Sitaw)
2 cups Baguio beans
2 cups Chayote
2 cups squash
2 eggs (beaten)
2 tablespoons chopped onions
1 cup coconut milk
1 cup water
3 garlic cloves, crushed
1 tablespoon iodized salt
2 tablespoons curry powder

Serves 8-10 people

Prepared and presented by Emily Damagong

Procedure

1. Scramble the eggs
2. Add garlic, onions, salt, water and coconut milk
3. Add the vegetables, cover and cook until tender
4. Add curry powder. Simmer for a minute

Vegetables with native ham

Ingredients

250 g native ham
1 bundle Amti
1 bundle Kangkong
1 bundle Chayote tops
1 onion
3 garlic cloves
Pepper

Procedure

1. Boil ham to soften then slice thin
2. Sauté garlic, onions and sliced ham
3. Add vegetables
4. Add seasoning when vegetables are cooked

Serves 4-6 people

Prepared and presented by Wima Fangloy

Eggplant omelette

Ingredients

3 eggplants
250 g ground pork
1 small pack tomato sauce
2 eggs
3 garlic cloves
1 onion
Cooking oil

Procedure

1. Slice the eggplant lengthwise and fry
2. Sauté the garlic, onions and meat
3. Add tomato sauce and add salt according to taste
4. Put the fried eggplants and sautéed meat into another pan and pour in the beaten eggs and cover until cooked

Prepared and presented by Avelina Sudario

Ginisang Upo

Ingredients
1 small Upo (bottle gourd)
2 garlic cloves
1 onion
Cooking oil
1 egg

Serves 4 people

Procedure
1. Sauté garlic and onions
2. Add sliced (cubes) of Upo
3. Add eggs when Upo is tender
4. Season with salt and pepper.

Nilagang Gulay

Ingredients
½ bundle Camote leaves
1 bundle okra
1 bundle eggplant
3 tomatoes
1 lime
Bagoong

Procedure
1. Prepare all vegetables
2. Boil for 5-10 minutes

Fresh zucchini with mayonnaise

Ingredients
Fresh zucchini
Mayonnaise
Ketchup
Sugar

Procedure
1. Wash and slice the zucchini into strips
2. Prepare the dip by mixing the mayonnaise, ketchup and sugar

Prepared and presented by Helen Higoy

Buttered vegetables

Ingredients

1 bundle eggplants
1 bundle Camote leaves
1 bundle Kangkong leaves
4 beaten eggs
2 cups flour
1 cup water
Salt and pepper
1 small pack Magic Sarap
Oil for frying

For mayo dip

1 cup mayonnaise
3 garlic cloves (grated)
Pepper and salt

Procedure

1. Mix flour, water, eggs, salt, pepper and Magic Sarap
2. Dip vegetables in batter and deep fry

Serves 6 people

Denengdeng

Ingredients

1 bundle Kalunay/Amaranth leaves
1 bundle okra
1 bundle eggplants
2 tomatoes
Bagoong

Procedure

1. Prepare vegetables
2. Boil water for 5 minutes
3. Add Bagoong and tomatoes
4. Add vegetables.

Serves 2-3 people

Sautéed spinach

Ingredients

Chicken meat (scraps)
200 grams native ham
1 bundle spinach
2 tomatoes
Garlic and onions

Procedure

1. Mince chicken scraps
2. Slice the ham thin
3. Sauté garlic and onions
4. Add the chicken and sliced ham
5. Add spinach and sliced tomatoes
6. Garnish with boiled eggs.

Serves 2-3 people.

Prepared and presented by Wilma Fangloy

COOKING CONTEST MENUS

Category A. Elementary schools (grade five pupils)

First place: Nagasi Elementary School

Okra and veggie ball sautée

Quantity	Ingredients
10 pcs	Okra (cut into strips)
1pc	Banana blossom
1 cup	Shrimps (shells removed)
1 cup	Tomatoes (seeds removed)
1	Onion
3 cloves	Garlic
Seasoning (small amount)	
2 packs of toasted bread	

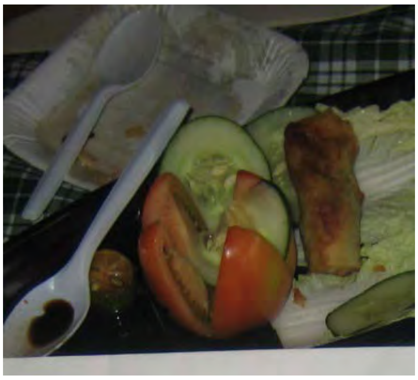
Procedure

1. Fry veggie balls and set aside
2. Sauté garlic ,onions and tomatoes
3. Add the sliced okra, cover for 3 minutes before stirring
4. Add the seasoning
5. When the okra is tender add the veggie balls
6. Garnish with onion rings

Second place: La Granja Elementary School

Lupo/Kulitis Lumpia Prito

Quantity	Ingredients
1 cup	Kulitis
1pc	Itlog
4 tbsp	Flour
3 pc	Tomato
1 pc	Spring onion
1 clove	Garlic
1 tbsp	Cheese
½ cup	Oil
½ cup	Green shell
12 pc	Lumpia wrapper
1 tbsp	Iodized salt



Procedure

1. Wash and blanch green shell
2. Slice Kulitis, Kamatis, green onion and garlic thinly
3. Scramble egg and add flour and salt gradually
4. Combine ingredients together with cheese and stir
5. Measure one tablespoon per Lumpia wrapper
6. Fry until golden brown and place on absorbent paper
7. Serve while hot with sauce

Third place: La Carlota North Elementary School

Laoynaw

Quantity | **Ingredients**
- 2 bundles — Alugbati
- 1 bundle — String beans
- 3pc — Okra
- ½ tbsp — Ginger
- 1 pc — Onion
- 1 cup — Shell (Punaw)
- 3 cups — Rice wash
- Salt (to taste)

Procedure
1. Add ginger and onion to boiling Kinilis and simmer for 2 minutes
2. Add ginger and simmer for 5 minutes
3. Add string beans and okra
4. Season with salt and cook until half done
5. Add Alugbati leaves. Cover and simmer for 30 seconds
6. Serve hot

Category B. Barangay level

First Place: Barangay Balabag

Birds's nest with shell

Quantity | **Ingredients**
- 2 cups — Malunggay
- 2 cups — Corn
- 2 cups — Shell (Punaw)
- 1 tbsp — Shrimp paste
- 1 tbsp — Flour
- ½ tbsp — Iodized salt
- 1 sachet — Baguio oil
- 4 cups — Water

Procedure
1. Boil corn
2. Wash and blanch shell and separate. Set aside the broth
3. Wash and blanch Malunggay
4. Remove corn grain from the cob using a knife. Set aside some of the corn grain
5. Chop corn, Malunggay and shell finely
6. Mix ingredients with egg and flour
7. Form into balls and deep fry. Set aside
8. Season the broth of the shell with shrimp paste and add chopped corn
9. Put empty shell in a serving bowl. Garnish the bowl with Malunggay leaves and fill the empty shells with balls and broth
10. Serve

Second place : Barangay La Granja

Emelden's omelette

Quantity	Ingredients
2 cups	Malunggay (stems)
2	Eggs
1	Carrot (grated)
3 tbsp	Flour
3 cloves	Garlic (crushed)
1	Onion (chopped)
¼ tsp	Black pepper
1 tsp	Sugar
2 tsp	Salt
½ cup	Oil

Procedure

1. Steam Malunggay leaves
2. Mix ingredients well, except oil
3. Fry in small individual servings
4. Place on absorbent material
5. Serve hot

Third place: Barangay Yubo

Ginataang Puso Ng Saging

Quantity	Ingredients
2 cups	Banana heart
2 cups	Squash (sliced)
2 cups	Munggo (cooked)
2 cups	Gabi (sliced)
1 cup	Malunggay
1 cup	Saluyot
3 cups	Coconut milk
½ cup	Okra(sliced)
½ cup	Shrimp
Iodized salt	
Shrimp paste	

Procedure

1. Boil water then add banana heart, thinly cut crosswise
2. Add Munggo, Gabi, squash and simmer for 5 minutes
3. Add okra and the remaining ingredients except Malunggay
4. Season to taste
5. Add Malunggay and serve hot

Annex I

Concept Note

Regional Symposium
31 May – 2 June 2012
"Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific"

Background and Rationale

Reduced dietary diversity has serious effects on the nutrition and health of rural and urban populations and deprives rural farmers of opportunity to generate income from their produce, whereas dietary diversification is widely accepted as a cost-effective and sustainable way of improving malnutrition. Neglected and underutilized food resources constitute the bedrock of the diversity in traditional and indigenous food systems of developing country communities. Traditional and indigenous foods are less deleterious to the environment and address cultural needs and preserve cultural heritage of local communities.

Indigenous people living in rural areas possess food resources that are usually not completely understood by agriculture and health sectors. This means that the usual processes of nutrition assessment and identification of food-based strategies for micronutrient promotion cannot take these resources into full consideration for planning. Indigenous peoples are often the most marginalized and disadvantaged for health care and other resources for well-being, and extreme poverty is often the result. Thus, most governments designate their indigenous peoples as those most in need of public health attention and food security. For these residents in rural developing areas, the "lifestyle and nutrition transition" experience means decreasing consumption of fish, wildlife, domestic animals and locally grown crops (rich sources of micronutrients) and increased consumption of industrially processed food. Poor micronutrient intake is a likely consequence, coincident with increasing obesity and other chronic diseases associated with increased caloric consumption in the form of simple carbohydrates and fat.

Successful food systems in transition effectively draw on locally-available food, food variety and traditional food culture. This involves empirical research, public policy, promotion and applied action in support of multisectoral and community based strategies linking rural producers and urban consumers with traditional and underutilized food systems. A few micronutrient promotion strategies using local food resources have demonstrated success. It is necessary to be aware of special considerations if successful food studies and nutrition-promotion activities are to be carried out with indigenous peoples using their own local food. Tools for the evaluation of traditional food systems of indigenous peoples would be helpful. Techniques for understanding local food availability and use, including scientific data for species, food harvest, storage and preparation practices, its acceptability for vulnerable members of the population; and potential for increased food availability and consumption are necessary data. There is also need to identify linkages between biodiversity, food and nutrition through s series of compiled case studies.

Lack of nutritional and agronomic information, a negative attitude towards traditional indigenous foods (termed foods for poor), policies that do not recognize sufficiently the important role of these foods in food security and health and lack of advocates/champions to promote traditional and indigenous foods. Traditional and indigenous food systems once lost are hard to recreate, underlining the imperative for timely documentation, compilation and dissemination of eroding knowledge of biodiversity and the use of food culture for promoting sustainable diets.

Objectives

The objectives of the regional symposium are:

i) to raise awareness on the role and value of underutilized indigenous food resources to dietary diversity and household food security;
ii) to share experiences and lessons learned for the promotion of partnership and networking among stakeholders at all levels; and
iii) to identify policy options and strategic actions for the promotion of underutilized indigenous food resources in Asia and the Pacific region, including evidence based research.

The discussions will be focusing on indigenous plants and animals including those from wild nature collected from uncultivated land, forest and from aquatic environments.

Outputs/Outcomes

- Case studies presented and documented highlighting efforts in promoting underutilized indigenous food resources.
- Policy recommendations, and short and medium-term action plans formulated to support sustainable use of underutilized indigenous food resources.
- A network of stakeholders established for knowledge sharing and future collaboration.
- Publication on indigenous food resources in Asia and the Pacific for promoting and disseminating underutilized indigenous food resources to improve diet quality and thereby improve nutrition.
- Symposium proceeding reflecting the outcomes and key recommendations discussed during the meeting with key messages, conclusions and recommendations.

Participation

Around 100-120 participants including senior officials from Governments, experts from the fields of agriculture, environment, health and nutrition, research and academic institutions, UN Agencies, private sector and indigenous people’s organizations are expected to attend. Members of the International Union of Nutritional Sciences Task Force on Indigenous Peoples’ Food Systems and Nutrition will also be invited to participate.

Date and Place

This two day meeting and one day field trip are scheduled to take place in 31 May - 2 June 2012. The event will be held in Khon Kaen, Thailand. The symposium will be followed by one day field trip on 2 June 2012 to traditional and indigenous farms in Khon Kaen areas.

Organizers

The event is jointly organized by the Food and Agriculture Organization of the United Nations (FAO), the Khon Kaen University in Thailand and National Research Council of Thailand, and Japan International Research Center for Agricultural Sciences.

Annex II

Regional Symposium
"Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific"

Agenda
31 May – 2 June 2012

31 May 2012, Thursday		
08:00-08:30	Registration	Organizing Committee – volunteers
08:30-09:00	**Inaugural Plenary session**	
	Congratulatory Message	President, Khon Kaen University, Thailand
	Inaugural speech	On behalf of H.E. Theera Wongsamut, Minister, Ministry for Agriculture and Cooperatives, Thailand
	Welcoming remarks	Secretary General, National Science Council, Thailand
	Inaugural address	President, JIRCAS
	Opening address	H. E. Hiroyuki Konuma, FAO ADG/RR
09:00-09:30	**Official Opening of Asia food exibition and food tasting**	
09:30-09:45	**Press conference (only by invitation)**	
09:45-10:45	**Thematic key note addresses**	
	Indigenous food diversity of Asia	Dr Krasit Tontisirin, President, Nutrition Science Association, Thailand
	Promoting traditional food systems for better nutrition and the Bioversity International nutrition strategy	Dr Leocadio Sebastian, Regional Director, Biodiversity International
	Challenging the conventional wisdom on underutilised species	Dr Michael Hermann, Global Coordinator, Crops for the Future
	Promoting Food diversity and Sustainable Diets	Dr Barbara Bulringame, Principal Advisor, FAO Headquarters
	The food chain from farm to table of local foods for health and well being	Dr Kamol Lertrat, Director, Food and Functional Food Research Cluster, Khon Kaen University
10:45-12:00	Open Discussion	Facilitated by Chair
12:00-13:00	**LUNCH**	
13:00-14:30	**Session I – Wild indigenous plants and animal sources**	
	Less visible but yet vital for human health: Nutrient-dense indigenous vegetables and their need for urgent promotion in balanced diets	Dr Keatinge, Director-General, World Vegetable Center
	Importance of biological survey on indigenous small fishes in rural areas for their sustainable use and management – A case study on growth and reproduction of	Dr Shinsuke Morioka, Senior Researcher, JIRCAS

	cyprinid Esomus metallicus occurring in central Laos	
	Wild mushrooms and their contribution to local diets - Country Case Study from Bhutan	Ministry of Environment and Forestry, the Royal Government of Bhutan
	Nutritionally rich wild vegetables of tribal communities of northeast India: Learning and lessons about traditional resources	Dr Rakesh Bhardwaj, Senior Scientist, National Bureau of Plant Genetic Resources, India
	Edible insect eating culture	Dr Kimio Matsumoto, President, The Japanese Society of Scarabaeoidology
	Medicinal wild plants for health, nutrition and vitality	Dr Jintanaporn Wattanathorn, Head of the Integrative Complementary Alternative Medicine Research & Development Group, Khon Kaen University
	Forest fruits for micronutrient deficiency - Experience from Mongolia	Dr Gombosuren Enkhtaivan, Head, Nutrition and Food Services Department, University of Science and Technology, Mongolia
14:30-15:30	Open discussion	Facilitated by Chair
15:30-16:00	**Herbal tea break with indigenous snacks**	
15:30-18:00	**Working group for Session I** - Documentation of local/traditional knowledge of use of diversity in developing strategies to cope with specific situations and recommendations made available on how to enhance good practices through their blending with scientific findings	
18:30-21:30	**DINNER RECEPTION WITH CULTURAL SHOW**	
1 JUNE 2012, Friday		
08:30-10:00	**Session II – farmed Indigenous plants and animals**	
	Farming edible insect as food for food security	Dr Yupa Hanboonsong, Faculty of Agriculture, Khon Kaen University, Thailand
	Returning Sago as main staple food for the eastern Indonesia Community	Ms Prastiwi Dewi Anggraini, Government Official, the Agency for Food Security, Ministry of Agriculture, Indonesia
	Glycine d-alanine aminopeptidase of Aspergilus oryzae, a fungus used for the production of traditional Japanese fermented foods	Dr Junichiro Marui, Professor, JIRCAS
	Farmers' Practices on Moringa (Moringa oleifera Lamk) Fresh Fruit in Some areas in Nueva Ecija and Pangasinan, Philippines	Dr Tomas D. Gajete, Central Luzon State University, Philippines
	Medicinal plants for health and vitality	Dr Jintanaporn Wattanathorn, Head of the Integrative Complementary Alternative Medicine Research & Development Group, Faculty of Medicine, Khon Kaen University
	Consumer's attitudes towards Edible Wild Plants - a case study from Noto Peninsula, Ishikawa Prefecture, Japan	Dr Chen, Postdoctoral Fellow, United Nations University, Japan
10:00-10:30	**Poster standing and coffee break**	

10:30-12:30	***Working Group for Session II*** - Networks and systems to promote greater access, sharing, conservation of food diversity and knowledge	
12:30-13:30	**LUNCH**	
13:30-14:30	**Session III – Research, Advocacy and Policy Frameworks for promoting underutilized foods**	
	Promoting utilized indigenous vegetables for high end food - from local to global	Ms Duangporn Songvisava, Private Sector, Food Enterprise
	The importance of recording local knowledge about under-utilized foods with reference to edible insects in Australia	Dr. Alan Louey Yen, Dept Primary Industries Victoria/La Trobe University, Australia
	Saving indigenous food knowledge for future food security and nutrition	Dr. Ekarin Phungpracha, Director, Faculty of Environmental & Natural Resources, Mahidol University
	Papeda a delicious sago porridge staple food in Indonesia	Ms Gayatri K. Rana, Director-General, Ministry of Agriculture, Indonesia
	Indigenous food resources for rural development policy	Dr Saito, Director, JIRCAS, Japan
14:30-15:30	***Working group III*** **–** - Policy options to promote greater use of local food diversity addressed and recommended at national and international level - Guidelines to mainstream the sustainable use of biodiversity for improved human nutrition in national food and nutrition action plans	
15:15-15:30	**Poster standing and coffee break**	
15:30-16:30	Feedback from the working group and reflection on three thematic session discussions	Working group rapporteurs and chairs
16:30-18:30	Plenary discussion for development of strategic plan of action	
18:30-19:00	Conclusion and the Way forward	Organizing Committee
19:30-22:00	**Symposium Banquet**	
2 JUNE 2012, SATURDAY		
09:00-16:00	**STUDY TOUR - Field visit to traditional and indigenous farms (packed lunch provided)**	

Annex III

KEYNOTE SPEECH

by

Hiroyuki Konuma
Assistant Director-General and
FAO Regional Representation for Asia and the Pacific

delivered at the

Regional Symposium on
"Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific"

Khon Kaen, Thailand
31 May 2012

Dr Kittichai Triratanasirichai, President of Khon Kaen University
Honorable guests,
Excellencies,
Ladies and gentlemen,

It is a great pleasure and honour for me to be here with you today. On behalf of the Food and Agriculture Organization of the United Nations, and on my own behalf, I wish to express my gratitude for the successful organization of the meeting.

Ladies and gentlemen,

FAO's mission is to strive for a world free of hunger and malnutrition where food and agriculture contribute to improving the living standards of all, especially the poor, in an economically, socially and environmentally sustainable manner. In this light, I should firstly like to review the present state of food and agriculture in the world, and in Asia.

State of Food and Agriculture

While living in a world of plenty, the scourge of hunger and malnutrition remains amid us. FAO estimates that there are 925 million people, about one-seventh of the world's population, going to bed hungry. In developing countries, one out of four children under the age of five is underweight and one in three children have low height with respect to their age (stunted) due to chronic undernutrition. Two billion people suffer from serious vitamin and mineral deficiencies, and it is estimated that 10 million children die before their 5th birthday every year, with one third of these deaths associated with undernutrition.

At the other side of the coin, overweight, obesity and associated chronic diseases are rising rapidly in low and middle income countries, made possible by rising incomes and urbanization, and access to cheap energy-dense nutrient-poor foods and increasingly sedentary lifestyles. It is estimated that around 43 million children under five years of age are overweight, and obesity affects around 500 million adults, increasingly in low and middle income countries, with consequences ranging from increased risk of premature death to serious chronic health conditions that reduce the overall quality of life.

The co-existence of overnutrition with non-communicable and chronic disease, such as diabetes, heart disease and certain cancers and under nutrition alongside micronutrient deficiencies is termed “the multiple burden of malnutrition”.

Feeding the World

While the world produces enough food today to feed every one, FAO is concerned that – at the present rate of production increases, might not be able to feel a world population estimated to reach 9.1 million by 2050. Prevailing constrains to increased food production are plenty: available lands fully exploited; progressing scarcity of water; impact of climate change (floods, cyclones) and the continuing degradation of natural resource base.

In addition, a number of macroeconomic factors do not bode well, such as high and volatile prices for crude oil; increased competition for land and water; and the food versus energy nexus.

Against this backdrop, FAO is advocating the need to maximize food production in a sustainable manner. The time for action is now, and we can no longer afford to wait.

Ladies and gentlemen,

Around 100 000 plant species for food, fibre, forage, fuel, crafts, industrial, cultural and medicinal purposes were used many years ago. At least 7 000 cultivated species are still in use today around the world. However, over the past more than 100 years, with increased contacts between disparate human populations and the development of a global trading system, 30 or so crop species have become the basis of most of the world’s agriculture.

The focus of research and crop improvement on a few widely used species has helped meet the food needs of the rapidly growing human population, but it has narrowed dramatically the number of species upon which global food security and agricultural incomes depend.

Forgotten Foods

Food consumption and production systems must achieve more with less, inter alia by shifting to nutritious diets with a smaller environmental footprint, and reducing food losses and waste throughout the food system. There is a need urgent action to promote a more diverse portfolio of species used in agriculture.

Against prevailing negative attitudes towards traditional indigenous foods – often termed food of the poor – FAO and partners are encouraging a revaluation of forgotten and neglected foods which are largely underutilized.

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.

Besides the policy emphasis on staple food (rice and wheat) and consumer preferences for a limited range of food products – most outspokenly observed in youth and in urban areas – FAO advocates increased attention to tap underutilized food resources produced on poor lands (wet lands, swamps) by the poor; as well as abandoned traditional and indigenous food resources, not looked after well by policy makers, researches, development partners.

Ladies and gentlemen,

<u>Stemming the Tide of Neglect</u>

Why we are promoting underutilized indigenous food resources? They directly contribute to local food availability and access by the poor. Many neglected and underutilized species are nutritionally rich and are adapted to low input agriculture. The use of these species – whether wild, managed or cultivated – can have immediate consequences on the food security and well-being of the poor.

The use of wilds plants has long been an intimate part of local cultures and traditions. Many neglected and underutilized species play a role in keeping cultural diversity alive. They occupy important niches, adapted to the risky and fragile conditions of rural communities.

Ethnobotanic surveys confirm that hundreds of such species are still to be found in many countries, representing an enormous wealth of agrobiodiversity that has the potential to contribute to improved incomes, food security and nutrition. However, these locally important species are frequently neglected by research and development. The primary challenge is help stakeholders to establish priorities for research, development and conservation actions on neglected and underutilized species.

Growing demand from consumers in developed and developing countries for diversity and novelty in foods is creating new market niches for neglected and underutilized species. These market opportunities can generate additional income.

Our present meeting is an important step in bringing together scientists, researchers, partners, government to exchange experiences and identify success stories and draw up action plan to maximize the production and consumption of valuable underutilized and indigenous foods in order to enhance food security in the world.

Go local. Enhance local food security; and maximize the utilization of locally available foods. These are a few of the key issues you will be addressing over the next two days.

I would like to express my deepest gratitude to the University of Khon Kaen, Thailand National Council for Science, Japanese International Research Center for Agricultural Sciences, Crop for the Future Initiative for their support in organizing this meeting.

I wish you all a productive meeting.

Thank you.

Welcoming and opening speech

by

Dr Kittichai Triratanasirichai
Associate Professor
President of Khon Kaen University, Thailand

delivered at the

Regional Symposium on
"Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific"

Khon Kaen, Thailand
31 May 2012

Assistant Director-General and Regional Representative FAO
Mr. Hiroyuki Konuma,
Secretary General of the National Thailand Research Council,
Distinguished delegates,
Ladies and Gentlemen,

On behalf of Khon Kaen University, I'm pleased to convey our pleasure and honor to host and co-organize this regional symposium on "Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific" and to welcome you to Khon Kaen, Thailand.

I especially wish to extend a warm welcome to delegates from abroad. I realize that you are fully committed to the sessions that will follow but I do hope you will also take time to enjoy fascinating Khon Kaen with friendly local people, food, and our Northeast Thailand culture, both as you stay in the city and join the field trip to nearby villages.
Thailand is giving strong emphasis on the development of agriculture, including the cultivating of various indigenous plants, animals and insects, to increase food production, food security and food nutrition. In fact, traditional indigenous foods in Thailand have been strongly promoted and are increasingly being recognized as "normal foods". And so, we will see an interesting array of indigenous foods, from farm to table, during this symposium.

Indigenous people living in rural areas often possess and consume food resources that are not completely understood by mainstream agriculture and health sectors. This means that the usual processes of nutrition assessment and identification of food-based strategies for micronutrient promotion fail to take these resources fully into full consideration. Yet, many of these foods are highly nutritious and offer tremendous opportunities to enhance food security and nutrition – and rural livelihoods. If we can successfully improve information on utilizing such indigenous food resources – including more effective marketing – rural producers, including indigenous communities, will benefit greatly in terms of improved health, nutrition, well-being, and poverty reduction.

I am pleased to note that this symposium has scheduled a half-day excursion, focusing on "traditional indigenous foods, including edible insects and mushrooms for food and income". In addition, various traditional indigenous foods will be featured and demonstrated (including opportunities for tasting!) at the "Indigenous Food Exhibition" at the front of this conference room.

I'm pleased to bring to inform you that Khon Kaen University has actively promoted greater awareness of indigenous traditional foods for many years and has worked diligently to transfer appropriate technologies related to under-utilized indigenous food production, processing and marketing to local people and small business groups. As you will learn in this symposium, and through the related food exhibition and field visits, these programmes, we have confirmed the potential and relevance of the local indigenous food production systems, which are clean, of high quality, safe and nutritious – and taste great! Thus, we have gained a high level of confidence in our traditional indigenous foods. It's our challenge to continue to build awareness and recognition of these goods to wider horizons.

In closing, I wish to express my gratitude to all delegates and observers for their full cooperation and contribution to the regional symposium on "Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific". I take this opportunity to thank the joint organizers: FAO, JIRCAS and NRTC, for organizing this meeting and for providing the necessary funding. I would also like to express my gratitude to the Organizing Committee for their diligence. The various sponsors for lunches and dinners are also thanked for their kind hospitality.

I wish the participants a very fruitful and productive symposium and hope that you have an enjoyable and memorable stay in Khon Kaen. And, for those with the time and opportunity, I would like to especially welcome and encourage you to visit Khon Kaen University during your stay.

I thank you.

Annex IV

Regional Symposium
"Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific"

List of Participants

Food and Agriculture Organization of the United Nations

Mr Hiroyuki Konuma
Assistant Director-General and
Regional Representative for Asia and the Pacific
FAO Regional Office for Asia and the Pacific
Thailand

Mr Patrick Durst
Senior Forestry Officer
FAO Regional Office for Asia and the Pacific
Thailand

Ms Nomindelger Bayasgalanbat
Nutrition Officer
Senior Forestry Officer
FAO Regional Office for Asia and the Pacific
Thailand

Ms Barbara Burlingame
Principal Advisor
Nutrition Division
FAO Headquarters
Italy

Thailand

Dr Kraisid Tontisirin
Senior Advisor
Mahidol University

Dr Peeradet Tongumpai
Director
Agricultural Research Development Agency

Dr Ekarin Phungpracha
Assistant Professor
Mahidol University

Dr Panya Mankeb
Assistant Professor
King Mongkut's Institute of Technology Ladkrabang

Dr Kriengsak Poonsuk
Associate Professor and Dean
Silpakorn Universiry

Dr Mana Kanjanamaneesathian
Associate Professor
Silpakorn Universiry

Dr Narin Preyavichyapugdee
Lecturer
Silpakorn Universiry

Dr Pantipa Na Chiangmai
Assistant Professor
Silpakorn Universiry

Dr Siwaporn Paengkoum
Deputy Dean International and Special Affairs
Silpakorn Universiry

Dr Gassinee Trakoontivakorn
Researcher
Institute of Food Research and Product Development
Kasetsart University

Dr Plernchai Tangkanakul
Researcher
Institute of Food Research and Product Development
Kasetsart University

Dr Wichian Voraputhaporn
Assistant Professor and Lecturer
Faculty of Technology
Khon Kaen University

Dr Pisit Charnsnoh
President
Yadfon foundation Trang

Dr Prasert Trakansuphakon
Executive Director
Indigenous Knowledge and Peoples

Dr Anan Polthanee
Professor
Dean of Faculty of Agriculture
Khon Kaen University

Dr Kamol Lertrat
Associate Professor and Director
Food and Functional Food Research Cluster

Dr Jintanaporn Wattanathorn
Head Integrative Complementary Alternative Medicine
Research and Development
Khon Kaen University

Dr Yupa Hanboonsong
Associate Professor
Khon Kaen University

Dr Krilert Taweekul
Assistant Professor
Khon Kaen University

Dr Yaowarat Sriwaranun
Lecturer
Khon Kaen University

Dr Satit Aditto
Lecturer
Khon Kaen University

Dr Patcharee Suriya
Lecturer
Khon Kaen University

Dr Bhalang Suriharn
Lecturer
Khon Kaen University

Dr Patcharin Songsri
Lecturer
Khon Kaen University

Dr Kiriya Sungthongwises
Lecturer
Khon Kaen University

Dr Ubon Tangkawanit
Lecturer
Khon Kaen University

Dr Fakjit Palinthorn Lapjit
Lecturer
Khon Kaen University

Dr Wanwipa Kaewpradit
Lecturer
Khon Kaen University

Dr Tasanee Jamjanya
Lecturer
Khon Kaen University

Ms Pornpanida Poochinda
Specialist
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Ms Aranya Puwilai
Government Official
Department of Agriculture
Ministry of Agriculture and Cooperatives

Dr Surachet Charoenkajonchai
Lecturer
OIA, Thailand

Dr Wirote Khlibsuwan
Lecturer
Khon Kaen University

Dr Ajin Phairiron
Lecturer
Mahaskham University

Dr Duangporn Songvisava
Lecturer
Bo.lan Essentially

Dr Yupa Pootangon
Lecturer
Silpakorn University

Mr Dylan Jones
Researcher
Bo.lan Essentially

International Research and Academe

Mr John Keatinge
Director General
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