Abstract nr. 790
Abstract code
Addressing the sustainability challenges through greater use of underutilized crops

Author Jaenicke, H., Crops for the Future, Colombo, Sri Lanka
Co-author(s) - Padulosi, S.
Co-author(s) - Bordoni, P.
Topic Track 3E - Sustainable agriculture
Keywords Crops for the Future,nutritional security,resilience to change,rural development

Abstract
Whilst “food security” in terms of calories produced may be addressed through starchy staple crops, “nutritional security” relies on adequate intake of protein, minerals and vitamins provided by many other crops, including legumes, fruits and vegetables. Indigenous or traditional plants are endowed with much of the agricultural diversity necessary for a healthy diet and are an important emergency food in times of shortages, for example in the lean season prior to main crop harvests. However, many of these crops have a stigma of being old-fashioned, are difficult to process or are in danger of disappearing as their suitable land areas vanish due to urbanization, climate change or population increase.
Over the past decades, researchers and development specialists have become increasingly interested in studying underutilized crops and their contribution to food security, nutrition and health, resilience to stress and risk (e.g. from climate change) and sustainable development. Many of these crops are grown in multi-storey homegarden systems, providing a sustainable production system. Promotion of these crops can also lead to increased on-farm diversity. Recent strategies for underutilized crops research and development highlight the need for interdisciplinary approaches, networking and links between stakeholders at all levels of society to attain sustainable solutions.

Crops for the Future is a new organization building upon this body of experience, with the aim to support, collect, synthesize and promote knowledge on neglected and underutilized species for the benefit of the poor and the environment. It thus fosters an integrated approach and innovative solutions in natural and economic systems.

Two ongoing multi-stakeholder projects, the “Coalition to Diversify Income from Underused Crops” and the project “Empowering the rural poor by strengthening their identity, income opportunities and nutritional security through the improved use and marketing of neglected and underutilized species” will be described in more detail to showcase integrated approaches on rural development, harnessing the benefits of underutilized crops, and addressing potential risks of over-promotion and over-exploitation.

Introduction

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”
When the Brundtland Commission wrote these famous words in its report “Our Common Future” (Brundtland, 1987) the world had realized that sustainable development is a global challenge. The report became instrumental in guiding the environmental Summit of Rio in 1992 and from there onward in shaping many other high-level political commitments and raising increasing attention on the topic of sustainability by a wide range of organizations and stakeholder groups.

After over 20 years, sustainable development – the interaction of environmental, financial and social sustainability – still faces a number of obstacles and challenges, most notably at the temporal dimension, i.e., the problem of not being able to look into the future. Whilst this can be addressed in part by building best bet scenarios as attempted in the Millennium Ecosystem Assessment (MA, 2005), the development of world and emerging economies and related consumption patterns are amongst the largest unknowns when trying to prepare our present environment for the challenges of the future. Issues include loss of biodiversity, desertification, soil degradation and limitations of water supply. All these are increasingly endangering a sustainable production of agricultural goods and they are linked to population growth and climate change. Whilst climate change is a recognized factor of impeding environmental pressure, it is unknown when, how and where exactly its effects will be felt.

A strategic answer to address this situation is to enhance people’s ability to adapt and cope with such changes. To that end, there is an increasing evidence of the positive role that underutilized plants can play in increasing people’s resilience to the effects of unpredictable changes and crises, thus improving the sustainability of their livelihoods (Jaenicke et al., 2009a). Those areas where underutilized crops can mobilize a key contribution include: (1) strengthening of food security, especially during crisis situations (extreme drought or flood, but also during increase in food prices of staple crops to which they can offer valid alternatives), (2) reinforcing nutritional security by making available diversified diets rich in minerals and vitamins in many staple crop-oriented societies, benefiting particularly children and elderly people, (3) providing income opportunities, often particularly to women, thus increasing a family’s flexibility in how to address household needs, (4) improving environmental sustainability in production systems by increasing agrobiodiversity components and enhance resilience and improved health within the landscape (Dawson et al., 2007).

However, many of these crops have a stigma of being old-fashioned, are difficult to process or are in danger of disappearing as their suitable land areas vanish due to urbanization, climate change or population increase.

What are underutilized plants?

Padulosi and Hoeschle-Zeledon (2004) discuss the concept and definition of underutilized crops and conclude that there is no short, clear-cut definition for this group of very versatile crops. These species are:

- important in local consumption and production systems;
- highly adapted to agroecological niches and marginal areas;
- ignored by policy makers and excluded from research and development agendas;
- represented by ecotypes or landraces;
- cultivated and utilized drawing on indigenous knowledge;

• hardly represented in ex situ gene banks;
• characterized by fragile or non-existent seed supply systems.

Jaenicke and Höschle-Zeledon (2006) go a step further and offer the following definition “Those species with under-exploited potential for contributing to food security, health (nutritional/medicinal), income generation, and environmental services”.

Whilst there is increasing interest in tapping these ‘dormant’ potentials, there is still only a mild response from the international community in putting greater efforts into developing these crops. This can be partly attributed to a general lack of credible success stories to substantiate the claims about these crops and to the fact that almost all underutilized crops have a very local value, often bartered by rural people and in many cases with limited value addition and export potential and thus of scarce appeal to national governments. In spite however of the challenges faced in substantiating the value of these species (due to the inadequacy of resources) results from a number of key international endeavours do indicate that these species represent a valid instrument for improving peoples’ livelihood, and reinforcing their resilience in periods of great physical and socio-economic changes.

History
During the years of the Green Revolution in the early 1970s, R&D was predominantly focusing on major commodities (staple crops and industrial species) which lead to a dramatic narrowing of the range of species on which the world rely upon (Fowler and Mooney 1990). An early response to this was the US National Academy of Sciences’ book on underexploited plants with promising economic potential (NAS, 1975). From the early 1980s to the 1990s a number of NGOs, national research organizations and international agencies worked on the collection, characterisation, domestication, crop improvement, documentation and (to a lesser extent) development of these crops (Padulosi et al. 2008). Collaborative activities on neglected and underutilized species gathered momentum in the 1990s. In 1992, the International Centre for Underutilized Crops (ICUC) started its operations in Asia with several multi-stakeholder seminars to determine regional and national priority species, concentrating at this stage on fruits and nuts and in 1993, IPGRI/Bioversity International launched an international project on underutilized species of the Mediterranean region and a series of monographs on 25 priority underutilized species (http://www.underutilized-species.org/record_details.asp?id=1065).

In 1996, FAO included underutilized species in its 20-Activity Global Plan of Action for PGRFA (FAO, 1996). In 2002, the Global Facilitation Unit for Underutilized Species (GFU) was established to provide better high-level coordination and political influence. Reacting on the recommendations that more efforts needs to be directed to support R&D on these species the first UN Global Project on neglected and underutilized species (NUS) was launched (Padulosi et al., 2003). At the 7th Meeting of the Conference of Parties to the CBD in 2004 a recommendation of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) was adopted on the recognition of underutilized species in improved food security and human nutrition while underlining also that interventions for their promotion should be directed towards the identification of constraints and success factors in marketing as a key aspect for their promotion and that capacity building at different levels is highly needed. Also in 2004, the EU included underutilized crops in its Framework Programme.

Recognizing that work to develop and promote underutilized crops is a multi-disciplinary effort

(Figure 1) and requires experts from different disciplines to work closely together, ICUC and GFU merged to form a new entity, ‘Crops for the Future’ in late 2008, which will work as an alliance with partner organisations. It is foreseen that this entity will:
• increase the knowledge base for underutilized plants, especially in the areas of sustained market access, nutritional security and health and climate change,
• advocate a favourable policy environment to promote the use of these plants,
• increase awareness on the potential and contributions of NUS for livelihoods and wellbeing and
• strengthen capacity in relevant sectors at different levels (CFF, 2008).

In the next sections we will discuss what specific contributions underutilized crops can make to address the key sustainability challenges of food security, nutritional security, income generation and sustainable productions.

Food security
Out of the 100,000 plant species used by people around the world (Heywood 1991), around 30,000 are edible, 7,000 are currently used at the local level (Wilson 1992) and just three of them, rice, maize and wheat, provide 60 percent of the world's food energy intake (FAO 1998). The main staple foods in the average African diet are (in terms of energy) cereals (46 percent), roots and tubers (20 percent) and animal products (7 percent). In Western Europe the main staple foods in the average diet are (in terms of energy) animal products (33 percent), cereals (26 percent) and roots and tubers (4 percent) (FAO, 1995).

The Food and Agriculture Organization of the United Nations (FAO) estimates that over 932 million people do not meet their daily required energy needs from their diets (FAO 2008). Millions more suffer acute malnutrition during transitory or seasonal food insecurity.

Children are the most visible victims of undernutrition which affects one in three of them in developing countries (de Onis 2000). Geographically, more than 70 percent of malnourished children live in Asia, 26 percent in Africa and 4 percent in Latin America and the Caribbean (FAO 2009). The International Food Policy Research Institute estimates that the number of malnourished children in Africa will increase by 18% from 2001 to 2020 (IFPRI, 2001). The inability to secure sufficient and quality food in many developing countries causes 40,000 deaths daily because of malnutrition, and millions more because of ailments related to their deficiency in iron, iodine, and vitamin A intakes (Hughes, 2009).

A vast number of plant foods are already known but either not being used or underutilized. Production and consumption of plant species used as food must be diversified. Not only do these crops contribute to better nutrition, during food security crises caused by natural or social calamities, these underutilized plant foods can act as a safety net to prevent starvation and to supplement emergency relief, which is often in the form of carbohydrates, with protein and micronutrients (Jaenicke and Höschle-Zeledon, 2006).

A good example to this respect is that of fonio (Digitaria exilis), a small cereal, cultivated in West Africa over centuries and highly adapted to the harsh dry conditions of the Sahel (Portères, 1976; NCR, 1996). This is one of the most nutritious cereals, for its rich content in methionine and cystine, important amino acids lacking in wheat, rice, maize, sorghum and other major cereals. The crop reaches maturity in just 6-8 weeks after sowing, earlier than the other cereals, which makes it an extremely valuable food during the weeks preceding the harvest of staples, a period

notably critical for local communities in the Sahel, whose granaries are usually empty at that time. But, ironically, the term ‘hungry rice” given to colonialists to this little researched crop, is highly misleading as it casts a shadow of food of the poor or last resort crop image to fonio, and does not pay justice to its nutritional qualities, its excellent taste (fonio is used to prepare delicacy dishes for special occasions), rich culture and traditions (Vodouhe et al., 2001; Adoukonou-Sagbadja et al., 2006).

Nutritional security

Humans need a balance between carbohydrates, proteins, fiber, and micronutrients in their diet. Relying on only a limited number of food crops causes environmental imbalance and food security risks, exacerbating the problems inherent in producing food of sufficient quality and quantity, in a sustainable manner, for a rapidly growing population.

The three most prevalent deficiencies and cause of illness and premature death throughout the world include iron (40 to 60% of the population), vitamin A (25%), and iodine (20%) (WHO, 2006). The effect of vitamin A deficiency in children is blindness and over 100 million children are affected worldwide. In women, iron deficiency results in anemia, this causes over 20% of all deaths in childbirth. In Ethiopia more than half of school-aged children are affected by iron deficiency (FAO, 2005). This impairs their ability to concentrate and learn. In many developing countries, iron deficiency is exacerbated by the diet which consists mainly of plant foods which generally contain less iron than meat, and in plant-based diets iron bioavailability is generally lower and can result in iron deficiency, even if the total iron intake is apparently sufficient (Ngegba et al., 2009).

Income opportunities

The growing demand from consumers in developed and developing countries for diversity and novelty in food is creating new markets for underutilized species. This situation can generate new opportunities for additional income for poor farmers in less-favored environments where these species have comparative advantages over staples or other commercial crops. The ability of modern technologies to transform raw materials into a wide range of products and to allow shelf life extension offers many opportunities to develop new uses and market these species and their derivates beyond their current commercial boundaries.

For example, the breadfruit (Artocarpus altilis) a multipurpose agro-forestry tree popular across the Pacific and the Caribbean regions, is a typical example of a highly nutritive species whose versatile applications are still largely untapped by the market. Immature fruits can be pickled or marinated, boiled mature fruits and ripe ones are used in countless recipes as vegetables or in confectionery for making cakes and desserts. Its seeds are eaten roasted, boiled or smashed into puree. It's timber is used in construction and bark and leaves are popular in traditional medicine. The male inflorescence are used as repellent for mosquitoes and as fruit and seeds as animal feed. (Vodouhe et al., 2001)

In addition, these plants offer interesting alternatives to producers and retailers alike:

• For the farmers they offer opportunities because these plants grow in the backyard of many households in a low-input agricultural regime or are gathered from the wild proving to be easily accessible.

• For the producers and retailers they offer opportunities for income generation if marketed in an appropriate manner. They often present comparative advantages on the “conventional” crops by striving in marginal lands and presenting a higher degree of resilience or resistance to adverse

conditions.
• Underutilized species attract the consumers by being nutritionally rich and helping to diversify diets.

On area that still needs improvement is the development of functioning markets for underutilized crops. The successful elements of a marketing strategy for these species has been identified as:
• Market information on underutilized species products is available and accessible to all actors of the marketing chain;
• Development of marketable products and innovative production and processing technologies;
• Use of the cultural heritage related to the area of origin of the products for product promotion;
• Availability of quality seeds and propagation material;
• Using an integrated value chain (VC) approach including the identification of suitable distribution channels, negotiation of prices and of conditions of delivery of underutilized species products (Breitschuh, 2004).

Whilst various value chains for neglected and underutilized species have been developed their potential remains untapped due to:
• Low competitiveness of actors along the entire VC, from input suppliers and producers up to traders, processors and retailers;
• Limited knowledge of private and public service providers concerning appropriate technology packages to promote NUS;
• Inappropriate rural development policies and programmes focusing on a limited number of commodities or cash crops; and
• Widespread mistrust between VC operators, as well as between private and public stakeholders (Will, 2008).

To unlock the potential of underutilized species, value chain development aims at addressing these shortcomings by facilitating the development of enabling framework conditions, VC-oriented services and sustainable business activities and relations along the VC, based on trust and long-term linkages between the different actors (Will, 2008).

Environmental Sustainability
Climate change per se is not necessarily immediately harmful; many problems arise from extreme events that are difficult to predict (FAO, 2001). More erratic rainfall patterns and unpredictably high and low temperature spells will consequently reduce crop productivity. Developing countries in the tropics will be particularly vulnerable. The FAO (2004) predicts latitudinal and altitudinal shifts in ecological and agro-economic zones, land degradation (e.g., salinization), extreme geophysical events (e.g. tornadoes), reduced water availability, and rise in sea levels. Increasing temperatures, reduced irrigation water availability, flooding, and salinity will be major limiting factors in sustaining and increasing crop productivity. Unpredictable drought is the single most important factor affecting world food security and the catalyst of the great famines in the past (CGIAR, 2003). Extreme climatic conditions will also negatively impact soil fertility and increase soil erosion, and cause pests and diseases to spread rapidly. Thus, food security in developing tropical countries will be at risk unless measures are undertaken to mitigate the effects of climate change and/or to find other sources of food.

Most exotic crops and modern varieties cannot withstand harsh environmental conditions. Thus,

there is a growing interest in underutilized crops and species that are adapted to difficult environments. These crops can be grown under poor soil conditions in marginal lands, such as steep, drought-prone, or saline areas. They are also often more resistant to pests and diseases. Many neglected and underutilized species are observed to thrive in these problem areas, whether in the wild or under cultivation. In many instances the underutilized species are the only ones that continue to grow in environments unfit for other crops (Hughes, 2009).

However, the threat of extinction is not smaller for underutilized species, in the contrary it might be higher because many disappear without much notice. Whilst the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) advocates increased conservation efforts, it lists only few underutilized crops. The Global Crop Diversity Trust works towards the ex situ conservation of crops listed in Annex 1 of the ITPGRFA – thousands more are in danger of disappearing without major global efforts. Maxted (2009) argues that threatened plant species need to be used in order to have a 'value' which makes their in situ or ex situ conservation recognizable as a worthwhile activity. Whilst placing such a value will in most cases not be easy or even possible, Maxted suggests to prioritise species – for different contexts and target uses – using parameters, such as existing usage, market niche potential and improvement potential, which can be estimated on a numerical scale. However, many underutilized crops would again fall through this mesh – their conservation must be carried out by the local communities, using local knowledge.

Case studies
The following two case studies illustrate integrated approaches to provide local communities with tools to improve their livelihoods, addressing the four key intervention areas food security, nutritional security, income opportunities and environmental sustainability.

1. Coalition to Diversify Income from Underused Crops
Rural communities in India and Vietnam rely on a small number of crops for food security and income generation. The effects of the green revolution in sacrificing species diversity for higher production of the main staple crops is felt strongly in both countries and diversification of farm options is necessary to provide sustainable income. Whilst the small farmers have access to crop diversity in their locality through usufruct rights, they have only limited opportunity to upgrade this produce as a commodity.

The Coalition to Diversify Income from Underused Crops (CoDI) is a group of organizations in India and Vietnam led by the International Centre for Underutilised Crops (Jaenicke et al., 2009b) to address this issue. In a novel approach, the coalition provides community services for production, post-harvest and marketing. The project provides technological and institutional innovation as well as learning opportunities for the coalition partners through continued internal monitoring cycles.

The coalition's interventions focus on four main activities:
1. Food Processing Parks, which provide training, information and business development services, processing, grading and other post-harvest activities and wider support on available market opportunities, credit advice and links to other value chain actors at local, national and international levels. Several Food Processing Parks have already been set up by the project with selected communities. Ultimately, they will be owned and managed by the communities.

2. Village Crop Fairs provide an opportunity to the communities to evaluate local fruits and plants and select the best ones for further production, distribution and sale.

3. Community Germplasm Orchards (nurseries) then receive planting material from the selected lines for further propagation. They also serve as training grounds for plant propagation and nursery management skills.

4. Annual Knowledge Fairs are a major element of the communication strategy and are organized at each site, to communicate and discuss the experience with wider stakeholders from the public and private sector. In addition, novel audio-visual information and training materials are being developed.

The coalition builds upon in-depth experience of each of the partners; in India on integrated rural development especially for tribal and marginalized farm communities; in Vietnam on making markets work for the poor by facilitating links between rural cooperatives and urban supermarkets, focussing on women farmers who form the majority of vegetable and traditional crops producers, in an increasing urban environment where many men move to the towns for off-farm employment.

The project has a comprehensive Monitoring, Impact & Learning system (MIL) to capture impacts on the beneficiaries' household income, skills development and related parameters. This component also contributes to broader efforts, beyond the immediate countries involved, to develop mechanisms for spotting 'future winners' at an early project development stage.

The project is within its first year of development but early results already show community empowerment and increased overall family income.

2. Empowering the rural poor by strengthening their identity, income opportunities and nutritional security through the improved use and marketing of neglected and underutilized species.
The first UN Project on NUS was developed as the most comprehensive effort ever launched to promote underutilized species at the international level. This project, supported by the International Fund for Agricultural Development (IFAD), which started in 2001 and is currently in its second phase, aims at strengthening nutrition security, income generation and ultimately the empowerment of local communities in poor marginal areas through the enhanced use of NUS. The project focuses (inter alia) on Andean grains in Peru and Bolivia, and minor millets in India and Yemen. This is a highly participatory and multi-disciplinary intervention, which follows a comprehensive value chain approach trying to remove all the impediments faced by target species so as to make them economically competitive and attractive to people. The project deploys a bottom-up and multi-stakeholder approach, with a special attention on women in recognition of the strategic role they play in the sustainable conservation and use of agrobiodiversity. It is being coordinated by Bioversity International and implemented in close collaboration with Fundación Promoción e Investigación de Productos Andinos –PROINPA (in Bolivia), the Centro de Investigación de Recursos Naturales y Medio Ambiente – CIRNMA (in Peru), the M.S. Swaminathan Research Foundation – MSSRF (in India), the Agricultural Research and Extension Authority – AREA (in Yemen), and the Italian-based NGOs Unità e Cooperazione per lo Sviluppo dei Popoli - UCODEP and Movimondo. So far, this international effort has been very successful in many regards, including securing and making available the diversity present in target species, developing improved agronomic practices, reduction of drudgery in processing practices, adding value to products (e.g. avoidance of nutritional degradation and expansion of range of palatable

dishes), training and building capacities among stakeholder groups, fostering the establishment of grassroots consortia (e.g. self help groups and cooperatives) and creating links among the actors of the value chains and raising awareness at local, national and international levels. A list of significant outputs produced by the Project is provided in Table 1.

An important output expected from the project is represented by the data that will be generated through the impact assessment study being carried out to quantify the change (in terms of improved nutrition, income and other social aspects) that the project will be making to the life of community members involved in the initiative. This would be a highly useful output for the international scientific community, donors and policy makers in view of the lack of ublished information providing solid proof of evidence to substantiate the claimed role of NUS in people's livelihoods and would help to attract the necessary attention from world's leader for the rescue and development of these orphan crops.

Conclusions

Over the past decades, researchers and development specialists have become increasingly interested in studying underutilized crops and their contribution to food security, nutrition and health, resilience to stress and risk and sustainable development. However, the world is facing a dramatic erosion of plant genetic diversity and knowledge related to underutilized crops. Globalized markets require more product uniformity and develop more uniform tastes, a growing urban elite in developing countries grows detached from rural traditions. It is now time for decisive action to reverse this trend and to support the sustainability of global development activities.

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) lists only few underutilized crops in its Annex 1. A revision of this list is urgently necessary, to allow bodies such as the Global Crop Diversity Trust to work towards ex situ conservation of more species. In addition, a major effort is needed to protect the many thousand species which cannot be conserved in gene banks, be it because they have recalcitrant seeds or for other reasons. For these species, traditional knowledge needs to be recorded, as well as opportunities provided for their continued use – without this they will surely become 'forgotten crops'. Crops for the Future has been established to increase the global knowledge base on underutilized crops and to continue policy lobbying on their behalf. Recognizing that not one organization can tackle the magnitude and diversity of the problem it works with strategic partners at all levels of society. Just as policy intervention is needed, increased support to grass-roots organizations will have a major impact on how people view, use and protect their traditional crops.

References

ADOUKONOU-SAGBADJA, H., DANSI, A., VODOUHE, R. &. AKPAGANA, K. (2006) Indigenous knowledge and traditional conservation of fonio millet (Digitaria exilis, Digitaria iburua) in Togo. Biodiversity and Conservation. 15,(8).

BREITSCHUH, U. (ed.) (2004). Expert Workshop "Marketing Strategies and Capacity Strengthening to Realize the Economic Potential of Underutilized Species". Workshop Documentation. Global Facilitation Unit for Underutilized Species, Rome, Italy.

BRUNDTLAND, G. (ed.) (1987) Our common future: The World Commission on Environment and Development. Oxford. Oxford University Press.

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH. (2003) Applications of molecular biology and genomics to genetic enhancement of crop tolerance to abiotic stresses – a discussion document. Interim Science Council Secretariat, FAO.

CROPS FOR THE FUTURE. (2008) Crops for the Future – Paths out of Poverty. Strategic Plan 2009-2013. 16 pp.

DAWSON, I.K., GUARINO, L. & JAENICKE, H. (2007) Underutilised Plant Species: Impacts of Promotion on Biodiversity. Position Paper No. 2. International Centre for Underutilised Crops, Colombo, Sri Lanka. 23 pp.

DE ONIS, M., FRONGILLO, E.A. & BLOSSNER, M. (2000) Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. Bulletin of the World Health Organization 78: 1222–1233.

DREO, J. (2006) http://en.wikipedia.org/wiki/File:Sustainable_development.svg

FAO. (1995) Dimensions of need. An atlas of food and agriculture. Food and Agriculture Organization of the United Nations. Rome, Italy, 1995.

FAO. (1996) Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture and Leipzig declaration, adopted by the International Technical Conference on Plant Genetic Resources, Leipzig, Germany, 17-23 June 1996. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO. (1998) The State of the World's Plant Genetic Resources for Food and Agriculture. FAO, Rome.

FAO. (2001) Climate variability and change: A challenge for sustainable agricultural production. Committee on Agriculture. Sixteenth Session Report. Rome, Italy 26-30 March.

FAO. (2004) Impact of climate change on agriculture in Asia and the Pacific: A challenge for sustainable agricultural production. Committee on Agriculture, Twenty-seventh FAO regional conference for Asia and the Pacific. Beijing, China 17-21 May.

FAO. (2005) The State of Food Insecurity in the World-2005. Food and Agriculture Organization of the United Nations. Rome, Italy.

FAO. (2008) http://www.fao.org/newsroom/en/news/2008/1000923/

FAO. (2009) http://www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm

FOWLER, C. & MOONEY, P. (1990) Shattering food, politics and the loss of genetic diversity. The University of Arizona Press. Tucson. 278 pp.

HEYWOOD, V. (1991) Conservation of germplasm of wild plant species. Pp. 189-203 in Conservation of Biodiversity for Sustainable Development. (SANDLUND, O.T., HINDAR, K. &

BROWN, A.H.D. (eds.). Norwegian University Press and Cambridge.

HUGHES, J. (2009) Just Famine Foods? What Contributions can Underutilized Plants Make to Food Security? Acta Horticulturae 806:39-48.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE. (2001) Annual Report. Washington, DC., USA.

JAENICKE, H., GANRY, J., HÖSCHLE-ZELEDON, I. & KAHANE R. (eds.). (2009a) Underutilized Plants for Food, Nutrition, Income and Sustainable Development. Proceedings of International Symposium held in Arusha, Tanzania, 3-7 March 2008. Acta Horticulturae 806. International Society for Horticultural Science. Leuven, Belgium. 739 pp.

JAENICKE, H. & HÖSCHLE-ZELEDON, I. (eds.) (2006) Strategic Framework for Underutilized Plant Species Research and Development, with Special Reference to Asia and the Pacific, and to Sub-Saharan Africa. International Centre for Underutilised Crops, Colombo, Sri Lanka and Global Facilitation Unit for Underutilized Species. Rome, Italy.

JAENICKE, H., BORGOYARY, M., TIWARI, S., DANIEL, J.N., ANH, D.T., HUNG, N.Q. & PASIECZNIK, N.M. (2009b) (this conference, track 5C). Coalition to diversify income from underused crops.

MAXTED, N. (2009) Use it or lose it: improving the conservation/use link as a tool to sustain agrobiodiversity. Acta Horticulturae 806:549-562

CARPENTER, S.R., PINGALI, P.L., BENNETT, E.M. & ZUREK, M.B. (eds.) (2005) Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being. Scenarios. Island Press. Washington, Covelo, London. Volume 2, 562 pp.

NATIONAL ACADEMY OF SCIENCES. (1975) Underexploited Tropical Plants with Promising Economic Value. Report of and Ad Hoc Panel of the Advisory Committee on Technology Innovation. Board on Science and Technology for International Development. NAS. Washington, D.C. 189 pp.

NCR. (1996) Lost Crops of Africa. Volume I .Grains. Board on Science and Technology for International Development, National Academy Press, Washington, D.C.

NGEGBA, J.B., MSUYA, J.M. & YANG, R.Y. (2009) In vitro iron bioavailability in sweet potato leaf recipes as affected by processing methods. Acta Horticulturae 806:385-390.

PADULOSI, S., NOUN, J.R., GIULIANI, A., SHUMAN, F., ROJAS, W. & RAVI, B. (2003) Realizing the benefits in neglected and underutilized plant species through technology transfer and Human Resources Development. In SCHEI, P.J. SANDLUND, O. T. & STRAND, R. (Eds.) Proceedings of the Norway/UN Conference on Technology Transfer and Capacity Building, June 23-27, 2003, Trondheim, Norway.

PADULOSI, S.& HOESCHLE-ZELEDON, I. (2004) Underutilized plant species: what are they? LEISA Magazine. March 2004: 5-6.

PADULOSI, S., HOESCHLE-ZELEDON, I. & BORDONI, P. (2008) Minor crops and underutilized species: lessons and prospects. In MAXTED, N., DULLOO, E., FORD-LLOYD, B.V., IRIONDO, J., KELL, S.P. & TUROK, J. “Crop wild relative conservation and use”. CAB International, Wallingford.

PORTÈRES, R. (1976) "African cereals: Eleusine, Fonio, Black fonio, Teff, Brachiaria, Paspalum, Pennisetum and African rice" In: HARLAN, J.R., DE WET, J.M.J. & STERNLER, A.B.L. (eds.) Origins of African Plant Domestication, Moulton, The Hauge, pp 409-452

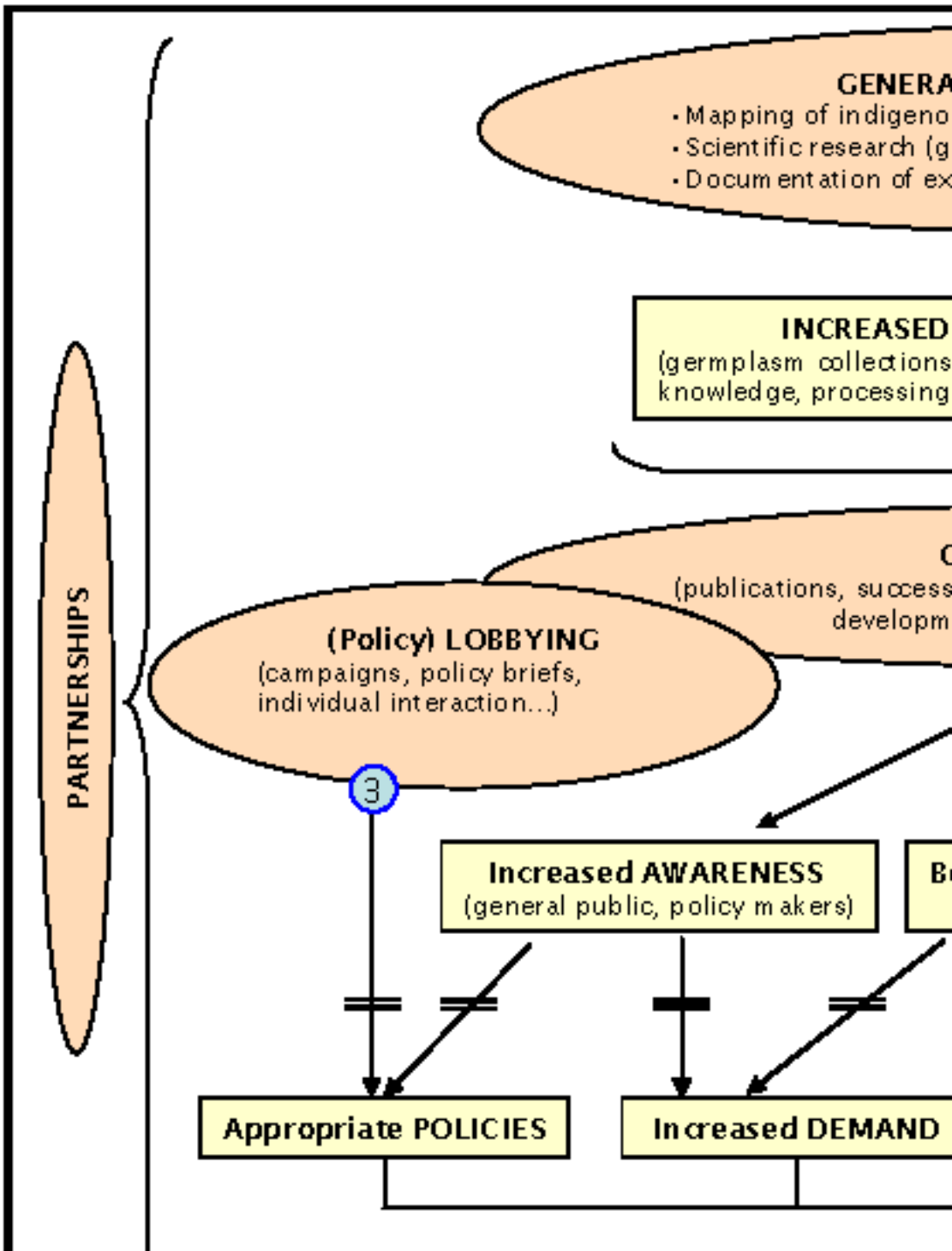
VODOUHE, S. R., ZANNOU, A. & DAKO, A. E. (eds.). (2001) Actes du Premier Atelier sur la Diversité Génétique du Fonio (Digitaria exilis) en Afrique de l’Ouest. Conakry, Guinée, 4-6 Août 1998. IPGRI, Cotonou, Bénin.

WILL, M. (2008) Promoting Value Chains of Neglected and Underutilized Species for Pro-Poor Growth and Biodiversity Conservation. Guidelines and Good Practices. Global Facilitation Unit for Underutilized Species, Rome, Italy.

WILSON, E.O. (1992) The diversity of life. Penguin, London, 275 pp.

WORLD HEALTH ORGANIZATION. (2006) The World Health Report 2006 - Working together for health. WHO, Geneva.

Figure 1: Intervention areas for the promoti
and Höschle-Zeledon, 2006)



Intervention areas for the promotion of underutili

Table 1: Activities and outputs of the UN project

Activities	Ouputs of the project
Collection, characterization and conservation of diversity and Indigenous Knowledge.	➢ **Identification of microcentres and development of core collections of target crops:** these activities are meant to facilitate future conservation and use strategies; ➢ **Accessions of target species collected from wild or cultivated sources:** accessions gathered (more than 670) will contribute to safeguard species' diversity and provide necessary material for crop improvement; ➢ **Establishment of community-based conservation efforts** (e.g. associations for conserving varieties, development of agreements within communities to allocate specific land to on farm conservation of unique varieties: these will support sustainable conservation of local varieties and facilitate the use of species at community level; ➢ **Upgrading of *ex situ* conservation facilities in target countries:** necessary interventions to help safeguarding diversity of target species at national level; ➢ **Organization of more than 30 Biodiversity Fairs**: these initiatives will foster exchange of varieties among farmers. They are also strategic occasions to recognize "custodian farmers" and promote their role within communities. ➢ **More than 7,000 accessions of material of target species regenerated and multiplied in gene banks:** these activities help facilitating the use of gene bank material and mobilize diversity held in existing collections often poorly deployed by R&D; ➢ **Reintroduction of lost varieties to farmers** (e.g. 30 varieties of quinoa, 9 of lupin): these efforts contribute to reconstitution valuable genetic resource base of target species in local communities and rebuilding strategic opportunity options for the people; ➢ **Development of a descriptor list (cañahua):** a instrument for researchers, very valuable to facilitate the understanding of NUS agro morphological diversity, too often very marginally understood; ➢ **Agro morphologic and nutritional characterization and evaluation of target diversity:** screening for resistance to pest and disease, early flowering, nutrient profiles in raw and processed products of target species, evaluating yield performance etc. are examples of the various activities aimed at assessing the value of different varieties. The data gathered by the project on more than the 2,000 accessions will help guiding marketing and promotion strategies;
Selection and dissemination of improved material to farmers	➢ **Participatory selection and introduction of germplasm involving more than 4,000 samples of target species (**more than 20 better performing varieties selected): selection and release to farmers of

Activities and outputs of the UN project - part 1

	improved varieties play a critical role in the promotion and further adoption of target species among farmers; ➢ **Distribution of planting material to users** (e.g. more than 2 tonnes of Andean grains seed and 4 tonnes of finger millet disseminated): dissemination of high quality seed pay a strategic role in the further adoption of target crops by farmers.
Documenting uses, enhancing market, commercialization and income generation and capacity building	➢ **Diversity catalogues on quinoa and amaranth**: these products help promoting a greater use of gene bank material by farmers and other user groups; ➢ **Surveys on cost benefits in cultivation and commercialization of target species as well as in other innovative income generation opportunities (such as ecotourism):** these studies help gaining a better understanding of constraints and opportunities faced by people in using target crops in their livelihoods; ➢ **Study the market system of target crops**: the better understanding of value chains is essential to guide their enhancement along with the fairer sharing of benefits among their actors; ➢ **Cultivation manuals of target species**: the development of improved cultivating practices and their dissemination in local language manuals/ farmers days and other methods will enhance efficiency of cultivation of target species; ➢ **Capacity building of actors of the value chain** (more than 300 courses and workshops organized on nutrition, cultivation, processing, value addition and marketing methods along with the hundreds of researchers trained): these are essential actions to create capacities in stakeholders groups and making them able to gain greater benefits form NUS for either their home consumption and/or income generation; ➢ **Strengthening community-based associations** (only in India, more than 35 SHGs and Farmers Clubs -involving as a whole nearly 400 people, majority women –have been established): these associations involved at different levels in the production and processing and marketing of target crops contribute towards the self-sustainability of the project beyond its life-span. ➢ **Recipe books on food preparations:** documentation and dissemination of traditional knowledge and novel food preparations in local languages contribute making NUS more attractive to people and new users, particularly the younger ones who are becoming nowadays increasingly detached from the traditions associated to NUS; ➢ **Enhancing of processing technologies**: the development of affordable machines for threshing, decorticate and mill target crops plays a critical role in promoting use at household and market level; ➢ **Development of alternative uses of target species**: the creation of novel food products - new snacks, drinks and organic products -and non-food products like natural colouring agents – is an important

Activities and outputs of the UN project - part 2

	stimulus in promoting use of NUS and their income generation competiveness;
Better policies and raised awareness	➢ **Developing and advocating new quality standards**: new standards for processing and commercialization are essential to strengthen the market of NUS, particularly the production directed towards the export; ➢ **Workshops, courses, video, radio, TV documentaries, promotional campaigns, articles in the national/international press in national and local languages:** all these activities are meant to contribute changing the image of food of the poor that too-often accompany NUS and raise awareness on their nutritional role; A BBC video on NUS produced by the project is available at http://www.underutilized-species.org/spotlight/video_spotlight/video_forgottenfruits.html ➢ **International Conference for policy makers on NUS**: these types of events create a visibility at the highest level and help underscoring the need of institutionalization of R&D on NUS by countries and various international agencies. For the proceedings of this International conference held in 2005 in Chennai, India see http://www.bioversityinternational.org/publications/pubfile.asp?ID_PUB=1170

Activities and outputs of the UN project - part 3

Presentation Preference
Additional information