

Realizing the Benefits in Neglected and Underutilized Plant Species through Technology Transfer and Human Resources Development

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Abstract

Neglected and underutilized plant species are a part of a wider Agrobiodiversity portfolio so far largely left at the margin of research and development. More recently, awareness on the potentials of these species in food and nutritional security, health and income generation has been increasing in the face of growing environmental and socio economic changes. The International Plant Genetic Resources Institute (IPGRI) is leading major initiatives in support of the use enhancement of these species in partnership with a variety of Stakeholders around the world, including local communities. Conservation of landraces, value addition and transfer of technologies and human resources development (HRD) are essential elements of these efforts, meant to capacitate stakeholder groups and contribute ultimately to create a sustainable mechanism for the full realization of the benefits arising from these species. The overall framework of such initiatives is an integrated approach that bridges complementary conservation methods with key activities of the production-to-use chain ("filiere"), including marketing and policy aspects, seen as essential elements to achieve sustainable use goals. An overview of recent contributions promoted by IPGRI in support of neglected and underutilized species (NUS) is given along with examples of the role that technology transfer and HRD activities have played in the area of germplasm conservation methods, safeguard and promotion of indigenous knowledge, post harvest, processing, add value, marketing and commercialization of end-products. Suggestions on the way

ahead in strengthening national and international efforts in this domain are also provided.

Introduction

IPGRI is one of the 16 Centers of the Consultative Groups on International Agricultural Research (CGIAR). Established in 1974, with the aim of encouraging, supporting and undertaking activities to improve the management of plant genetic resources worldwide, has as its ultimate goal that of eradicating poverty, increase food security and protect the environment (IPGRI 1999). IPGRI's efforts are directed towards the conservation and sustainable use of plant genetic resources (PGR) that are particularly relevant to developing countries.

Justifications for IPGRI's emphasis on NUS in its research Agenda are found in the significant contribution that these species bring towards improving people's livelihood, in terms of food and nutritional security, income generation and better health, particularly for the more vulnerable members of society, such as the poor, the women, the children and the elderly groups.

Neglected and underutilized species are often referred to using a wide array of synonyms, s.a. minor, orphan, underexploited, underdeveloped, lost, new, novel, promising, alternative, local, traditional, niche crops, etc.. Apart from the terminology used (loaded with heavy cultural meanings and hence far to be universally easily understood), these species are characterized by a common denominator: they suffer from poor research and conservation efforts, while their socio economic potentials are not fully exploited (Padulosi et al 2002a). A closer analysis reveals common symptomatic features for all NUS, which can relate to challenges and opportunities encountered in their promotion process (box 1).

These species have never attracted enough attention of policy makers simply because they could never compete with major commodity crops, commanding larger economic interests. Their contribution to improve the lives of millions of people around the world is however a silent one but extremely relevant, particularly at the local level, where their cultural significance is high and where they compete with commodity crops in terms of better provision of essential micro-nutrients, affordable health remedies, income generation, adaptation to low input agriculture, marginal lands and changing environments (Bhag Mal, 1994; Arora and Pandey, 1996, Padulosi et al., 2002b, Prohens et al., 2003). Indirect benefits include also contribution to agricultural diversification, broadening of diversity in agro-ecosystems, reduction of imports and self reliance enhancement in agricultural production systems (Williams and Haq, 2002).

Box 1

Common features that characterize neglected and underutilized species (grouped in terms of challenges and opportunities encountered during their promotion process).

Challenges

- Little attention by National Policies, R&D
- Poor documentation (distribution, biology, cultivation, genetic enhancement, uses etc.)
- Non existent/poorly organized marketing & production-to-use chain
- Scarcely represented in ex situ germplasm collections
- Maintained mainly through in situ /on-farm conservation
- Characterized by non existent/fragile seed supply systems

Opportunities

- Highly adapted to agro-ecological niches/marginal areas
- Characterized by multiple uses

Challenges and opportunities

- Local importance in consumption and production systems
- Represented mostly by wild species, ecotypes, landraces
- Cultivated and utilized relying largely on Indigenous Knowledge

Recognition of the role played by NUS has stemmed out from many national and international fora, including the FAO IV International Technical Conference on Plant Genetic Resources for Food and Agriculture (cfr. Activity 12: "Promoting development and commercialization of underutilized crops and species") (FAO 1996) and the Global Forum on Agricultural Research (GFAR), which has been instrumental for the establishment of a German-supported Facilitation Unit for Underutilized Species (Frison and Padulosi, 2000).

Addressing the sustainable promotion of NUS has required IPGRI to develop a specific strategy that building upon the Institute's past experiences, sets out a clear road map in tackling challenging and opportunities in such pursuit. The ultimate goal of IPGRI's strategy on NUS is to strengthen the capacity of stakeholders to maintain and enhance the biological assets of the rural poor by enhancing and deploying a broader range of species adapted to diverse environments and providing new opportunities for better nutrition and income generation (IPGRIa, 2002). IPGRI's main objectives in addressing NUS are:

- Develop priority-setting approaches at the local, national and international levels and assist stakeholders to establish priorities for research, development and conservation actions on neglected and underutilized species that increase their contribution to and impact on sustainable agriculture and livelihoods of the rural poor, and broaden the bases of food security.
- Enhance the conservation and use of plant genetic resources of neglected and underutilized species through complementary approaches to genetic resources from production to consumption.
- Strengthen the efforts of other actors working on the documentation, evaluation, improvement, processing and marketing of neglected or underutilized species.

The overall framework of IPGRI's efforts on NUS, is made of eight major domains of work, which are described in this paper along with examples on how IPGRI has been addressing them in partnership with National Programmes. The role of technology transfer and HRD in these efforts is highlighted.

Enhancing neglected and underutilized species: IPGRI's experiences

Sharing the knowledge

Information plays a crucial role in enhancing the use of neglected and underutilized species. Often, little is known about the extent of their cultivation, agronomic requirements, local uses and values, and contribution to local food security and environmental sustainability. Gathering and sharing information among all stakeholders is essential to promote greater use of NUS. IPGRI efforts are directed towards the provision of information on species, techniques and approaches to support their improved conservation and use. At the national level, ethnobotanical surveys of NUS linked to agricultural and economic development are important first steps. IPGRI pays special attention to the maintenance and documentation of local knowledge systems on the uses and management of germplasm of these species. An Internet web site is maintained to disseminate inter alia information on IPGRI's and partners' activities in this area, including publications and databases.

Relevant examples from IPGRI's activities in this domain:

- **Development of germplasm catalogues:** Activities carried out in China and Bolivia have produced so far germplasm catalogues for a number of species, including safflower (Zhang and Johnson 1999) and quinoa (Rojas et al. 2001). The Germplasm Directory for Latin America and the Caribbean is also a useful source of information on NUS holdings in this region (Knudsen, 2000).

- **Data bases:** A germplasm collection data base on rocket (*Eruca* and *Diplotaxis* species) was promoted and developed in participation with the Italian Germplasm Institute (National Research Council - CNR) and other partners joining an International Rocket Network coordinated by IPGRI (Padulosi and Pignone 1997). A database to document the diversity of pomegranate accessions held at the Garygala Research Station, Turkmenistan, was also developed through on-the-job training of local experts. This activity was particularly valuable in consideration of the fact that this field gene bank (established by N.I. Vavilov in the early 1930s and containing more than 1,000 accessions of cultivated and wild *Punica granatum*) had no electronic documentation and precious data related to the collection (passport as well as characterization data) were destined to be lost for ever due to poor documentation.
 - **Food recipes:** This is an area gaining increasing importance in recognition of the role that food recipes can play in promoting the use of NUS by appealing to people's renewed attention to culture and traditions. IPGRI's partners in Latin America (Bolivia, Ecuador and Peru) have been actively engaging local communities – including women organizations – in the development of booklets in which traditional recipes have been documented and disseminated to users. Andean grains [quinoa (*Chenopodium quinoa*), cañihua (*C. pallidicaule*), amaranth (*Amaranthus caudatus*) and lupin (*Lupinus album*)] have been the focus of these efforts (Pacosillo and Chura, 2002; Rojas and Padulosi, 2003).
 - **Documenting uses:** Sharing knowledge on uses of NUS is strategic as it relates directly to the maintenance of their genetic resources by the users' communities. Given the increasing erosion and loss of Indigenous Knowledge affecting NUS (Padulosi et al., 2002; Noun et al., 2001), these activities need to be strengthened decisively. IPGRI's most recent outputs in this domain, include the support for the publication of a book on edible plants of Kenya describing 800 indigenous plant species used for food in one way or another (Maundu et al., 1999) and the ethnobotanic survey on more than 200 indigenous plants in Lebanon used as leafy vegetables, medicinal and aromatic purposes (Noun et al. 2002 and Noun, 2003).
 - **Bibliography of NUS:** Access to proper data and experiences is essential to promote uses of NUS and enhancing knowledge and capacities of National Programs around the world. A particularly valuable product in this domain is the bibliography on native fruits of Latin America, produced by IPGRI in 2000 and available on IPGRI's internet web page (<www.ipgri.cgiar.org>). Another useful bibliography to assist researchers in Africa is that on the genetic resources of traditional African vegetables (Mnzava et al. 1999). A specific inventory on underutilized edible fruits and nuts in their regions of diversity was produced by IPGRI in 1998 (Pareek et al. 1998). The Institute's partners in Bolivia, Ecuador and Peru are currently compiling all available published literature related to Andean grains and making it available to students and other workers (this valuable resource centre is being created at the PROINPA Foundation's library in La Paz, Bolivia). Included in this reference collection are University theses produced by students in Bolivia insofar which have been addressing specifically Andean grains. The compilation and dissemination of research findings on NUS is a very important aspect, requiring greater attention; the so called "grey literature" consisting often of valuable publications poorly known within the scientific community should be indeed better shared among scientists and all other users for enhancing the sustainable use of NUS.
 - **Crop monographs:** The provision of comprehensive information, from geographical distribution of genetic diversity and conservation, to breeding, agronomy, post harvest, processing, add value, marketing and uses, is a particularly significant instrument to support National Programs in better realizing the benefits from their biodiversity endowments. Thanks to a German-funded Project, IPGRI has been very active in this domain and 23 publications on priority crops have been produced so far (Cowling et al. 1998). These monographs can be downloadable for free at IPGRI's internet web page dedicated exclusively to neglected and underutilized species: <www.ipgri.cgiar.org/nus>.
 - **Ecogeographic surveys:** the understanding of the distribution of the genetic diversity of NUS is generally very poor. IPGRI has supported several studies to improve this situation, which resulted into useful scientific publications. Major outputs include the ecogeographic study of the genus *Vicia* (Maxted, 1995) and *Corchorus* in Africa (Edmonds, 1990) and the identification of microcenters of genetic diversity for quinoa, amaranth and lupin in Ecuador (Tapia, 2002a). Recent ecogeographic surveys on laurel and pomegranate in Syria were combined with fruit quality analyses of surveyed populations, revealing opportunities for better deployment of existing diversity in income generation (Yousef, 2003; Hadj-Hassan et al. 2003)
- Where to start: setting priorities for NUS**
- NUS are part of a large portfolio of diversity, available in the order of hundreds in many countries around the world (Padulosi et al. 2001). In view of these sheer numbers and the variety of needs and disciplines involved in supporting their conservation and use, the adoption of a structured approach to the selection of

priority species and activities is hence essential. This approach allows making best use of resources, notoriously very limited in the case of NUS. Fundamental in priority setting process is that selection criteria need to result from fully participatory, bottom-up and gender sensitive consultations among all stakeholders.

Relevant examples from IPGRI's activities in this domain:

- **Priority setting workshops:** Processes and tools have been developed and tested by IPGRI in various occasions (Padulosi 1999a). Most relevant are the Conference on NUS for the Mediterranean Region held in Aleppo, Syria, in 1998 (Padulosi 1999b) and the Stakeholders' Workshops organized in 2001 by IPGRI in connection with the IFAD-IPGRI Global Project on NUS launched at the end of 2001. These latter consultations were held with the active participation of a very diverse group of representatives from the formal and informal sector and led to the formulation of a truly multi-Stakeholder regional work plan to address the use enhancement of Andean grains (focus in Bolivia, Ecuador and Peru), nutritious millets (focus in India and Nepal) and medicinal and aromatic plants (focus in Egypt and Yemen).

Bridging the gap between promotion and use

In its work with local communities, IPGRI is engaged in identifying strengths and weaknesses within existing production systems, including seed supply systems, typically very weak or not existent at all in many NUS. Working closely with farmers, IPGRI looks at ways to identify and improve agro-morphological traits needed to enhance the use of these species in agro-ecosystems which are useful also in meeting market demands. IPGRI does also support activities to assess the genetic potential of NUS, crop enhancement work (especially participatory plant breeding) and address key bottlenecks such as seed production and plant multiplication (including the development of micro-propagation techniques). In view of the fact that, as crops are improved and become more commercialized, loss of genetic diversity may occur, attention is paid to assess the impact of crop improvements and market promotion on the distribution, use and maintenance of NUS genetic diversity.

Relevant examples from IPGRI's activities in this domain:

- **Domestication and agronomic requirements:** *Gundelia tournefortii* ("akoub" in Arabic): is used to prepare a famous food delicacy in the Middle East, but unsustainable harvests of young shoots from its wild populations, pose great threats to its own survival (Noun, 2003). IPGRI has supported a research study in Lebanon to look at its domestication and cultivation practices needed to release the pressure in the wild while creating income opportunities for

local communities. Similar genetic erosion threats are being faced by sage (*Salvia fruticosa* –a medicinal/aromatic plant with large economic potentials), oregano (*Origanum syriacum* –an industrial and ornamental species) and chicory (*Cichorium intybus* –a leafy vegetable) all very popular species in Lebanon and in the Middle East. For these species too, domestication efforts and characterization studies have helped considerably the understanding of their cultivation needs: adequate germplasm and cultivation techniques made available to local farmers interested in their better exploitation have contributed to release pressure on natural populations (Kaddoum et al., 2001; Noun and Kaddoum, 2001; Noun, 2003).

- **Participatory evaluation:** In 2001 and 2002, IPGRI's partners in India carried out the participatory evaluation of 3,486 accessions of finger millet (*Eleusine coracana*), 1,191 of Italian millet (*Setaria italica*), and 452 of little millet (*Panicum miliare*). Demonstration plots for local farmers were also established during these activities. Screening for mildew-resistant, early maturing and high yielding quinoa was also carried out in Ecuador, Bolivia and Peru in 2002 and 2003. In Bolivia, 4 quinoa best genotypes were eventually selected and are currently being multiplied for their release to farmers. Participatory selection of best genotypes has been carried out also for a number of tropical fruit species s.a. mangosteen, rambutan and jackfruit within the framework of an IPGRI-led International effort supported by the Asian Development Bank.
- **Enhancement of cultivating/add-value techniques:** Improvement of cultivating practices for yield optimisation in nutritious millets has been achieved in India and Nepal by a team of agricultural experts working closely with farmers. Organic agriculture investigations focusing on Andean grains and medicinal and aromatic plants in Ecuador and Egypt, respectively, have been also carried out in early 2003 to investigate on add value techniques to enhance the competitiveness and income generation of these species.
- **Post-harvest technologies:** The IPGRI-IFAD Project on NUS has deployed special efforts to make processing of these crops by local communities more effective. Its Andean component has so far developed a prototype of a simple manual threshing machine with inputs of local producers and communities. This machine is now being adopted by several producers in Bolivia. The sharing of an inexpensive innovative processing technology for fonio (*Digitaria exilis* – a small cereal cultivated in West Africa) has been also supported by IPGRI through a participatory Workshop organized in 2001 in Bamako, Mali, attended actively also by women as

primary users of this innovative technology (Vodouhè and Dako, 2003).

- **Descriptor lists for characterization:** Descriptors lists are essential in understanding diversity of crops and hence in promoting their sustainable use. They are even more strategic for NUS, in view of the fact that these species lack most of those instruments necessary to guide characterization and evaluation activities easily available for commodity crops. Descriptors lists produced so far by IPGRI and its partners amount to more than 80, those that specifically address NUS include: bambara groundnut, buckwheat, jackfruit, kodo millet, lupin, quinoa, safflower, winged bean and rocket (IPGRI 20002b). The first descriptor list for cañahua was recently developed by IPGRI's partners in Latin America. The development of descriptor lists in close partnership with National Programs has benefited researchers around the world in a number of ways: significant is the transfer of skills necessary in their production and the strengthening of cooperation and networking among countries gained by all participants in the development processes (Laliberté et al. 1999).

Maintaining diversity sustainably

Because of the poor conservation, high genetic erosion and the little information on the ecogeographic distribution of many of these species, surveying, taxonomic identification and analysis of the extent and distribution of genetic diversity, together with work on local and traditional knowledge is highly needed. Complementary conservation strategies required to combine in-situ/on farm conservation with ex-situ conservation so as to provide back-up systems and material for access by users need to be implemented. Activities to address specific bottle necks to pursue these objectives, such as reproductive biology, in vitro conservation and ways of eliminating viruses from vegetatively propagated species, are also considered important under this group of efforts.

Relevant examples from IPGRI's activities in this domain:

- **Sampling of diversity:** Andean grains have been surveyed and sampled through participatory missions involving experts and community members working closely together. The results of these expeditions carried out in 2002 (50 acc. amaranth, 107 acc. of quinoa and 59 acc. of cañihua sampled in Bolivia, 586 acc. of quinoa in Peru) are used in evaluation and participatory selection activities. Useful wild species from the indigenous Lebanese Flora have been surveyed and sampled in the period 1999-2000 (195 accessions of *Origanum syriacum*, 53 of *Salvia fruticosa*, 102 of *Cichorium intybus* and 82 of *Gundelia tournefortii*) and are now available to farming communities (Noun, 2003). 37 accessions of pomegranate varieties from Syria

were collected in 2001-2002 through an IPGRI-supported MSc Thesis Research effort in collaboration with the University of Aleppo, Syria (Yousef 2003).

- **Rejuvenation/ multiplication in gene banks:** During the period 2001-2002, 88 accessions of lupin, 479 acc. of quinoa and 230 of amaranth have been multiplied at the INIAP gene bank in Ecuador (Mazon et al. 2002) whereas 555 acc. of cañihua and 248 of quinoa by the PROINPA's gene bank in Bolivia (Rojas et al., 2002; Guzmán, 2002). Worthwhile to highlight that within the framework of the IFAD-IPGRI Project on NUS, between 50 and 100% of national collections of quinoa, cañahua, amaranth and lupin held in Bolivia, Ecuador and Peru, have been successfully regenerated and multiplied during the period 2002-2003.
- **Provision of NUS material to farmers:** Through the empowerment of local experts (establishment of Local Committees of Agricultural Investigations - CIALs) in Ecuador, the selection of best genotypes and their multiplication and release to farmers, was pursued by IPGRI and its partners in a very effective way. In Lebanon, transfer of *Origanum syriacum* seeds and seedlings to farmers was carried out in cooperation with ICU (an Italian NGO executing development projects in South Lebanon) along with the organization of training courses to capacitate farmers on cultivating techniques.
- **Exchange among farmers:** 490 farmers and 16 private companies attended seed fairs on Andean grains organized by IPGRI's partners in Bolivia, Ecuador and Peru, where champion farmers were also awarded for their contribution in maintaining large crop diversity on farm (Guzman et al. 2002; Tapia, 2002b; INIA, 2002).
- **Establishment of field gene banks:** A cherimoya (*Annona cherimola*) field gene bank was established in 1998 at the INIA sub-Station in Ayacucho, Peru, thanks to the support of INIA-Spain, within an IPGRI-led initiative aimed at enhancing the use of this underutilized fruit tree native to Peru and Ecuador. This collection, made of more than 250 accessions, will represent an invaluable source of material for the Peruvian National Programme engaged in selecting improved material of this crop. A field gene bank of local varieties of Syrian pomegranates was also established in 2002, within a capacity building project jointly executed by IPGRI and the University of Aleppo (Yousef, 2003).
- **Refined technologies:** Improved methods to better maintain and characterize germplasm of NUS were developed in 2002 for the tropical fruits mango, rambutan and jackfruit. This IPGRI's led

effort was carried out through the close cooperation of 10 Asian countries participating to a ADB (Asian Development Bank)-funded Project on Tropical Fruits.

- **Enhancing local conservation practices:** The capacitation of communities in conserving their resource base of crop diversity is very strategic, particularly for NUS. Community gene banks have been successfully established in East Asia to safeguard both germplasm and indigenous knowledge of mangosteen, rambutan and jackfruit. Similar efforts in the Andean region, led to the establishment of 6 local gene banks for quinoa and other Andean grains (4 in Peru and 2 in Ecuador). In India, the establishment of local seed banks in close participation with farm communities at Kolli Hills, (Southern India) by M.S. Swaminathan Research Foundation (MSSRF), has helped in promoting in situ/on farm conservation of traditional land races of nutritious millets. The communities are encouraged to store the seeds in traditional storage structures called "dombai". The seed bank approach has also helped communities in seed sharing to overcome seed shortages, frequently encountered among farmers.
- **Establishment of core collections:** Core collections are useful instruments to promote the use of plant genetic diversity (Johnson and Hodgkin, 1999). Core collection of Andean grains have been developed in Ecuador and Bolivia to facilitate the use of ex situ germplasm collections of these crops. In Bolivia, this work was carried out on 2,514 accessions of quinoa using 18 quantitative variables: statistical analyses led to the identification of 6 representative groups of accessions, each group contributing for a specific genetic variation to the core collection made of 267 accessions.
- **Capacitating local producers:** Training courses targeting local producers of Andean grains were carried out in 2002 at the Peruvian gene bank in Puno. Here local growers and processors have learned of the diversity-rich national germplasm collection, and discussed with scientists ways to enhance uses of these crops by making better use of the ex situ collection.
- **Enhancing cultivating practices:** In India and Nepal efforts have been spent in 2002 to develop better agronomic operations that would optimize the yield of nutritious millets.
- **Quality standards:** In view of their importance to promote marketing of NUS, quality standards have been addressed by IPGRI's partners consistently both for Andean grains and for nutritious millets. In Bolivia in particular, a ad hoc Committee of experts

was established in 2002 to elaborate the first quality standard norm for the cultivation and processing of cañahua.

- **Seed storage behaviour:** Often little is known on the seed behaviour of many NUS species conserved in ex situ gene banks. A valuable tool for gene bank managers is the IPGRI's seed storage compendium (Hong et al. 1996) which complements other gene bank management publications produced also by IBPGR/IPGRI insofar.

Enhancing use through better marketing

Strengthened market systems are crucial to the promotion of neglected or underutilized species. Better commercialization translates into greater opportunities for income generation by the poor farmers who cultivate these species. Efforts in this domain have been directed at (i) identifying opportunities to add value through improved preparation or processing methods and the development of low cost technologies and providing access to these technologies to the village communities, (ii) marketing activities including user and market niche definition and improving price, distribution, presentation and promotion of entrepreneurship; (iii) creating and identifying opportunities and capacity building to develop new products and markets, (iv) identifying ways to ensure that the nutritional contributions of selected NUS are recognized and integrated into national nutritional goals, (v) developing public awareness activities for crops and products at local and national levels and integrating such work in development-related activities, for example in-situ and on-farm conservation and home gardens.

Relevant examples from IPGRI's activities in this domain:

- **Capacitating courses:** Training in commercialization and marketing were organized for local entrepreneurs in Peru in 2002. These courses, focusing on cañahua, were attended by 479 local producers from 7 local communities. Skills developed by the producers during these courses will strengthen their capacities in marketing Andean grains at local and regional level.
- **Adding values:** IPGRI's partners in India, Nepal and Latin America have organized several workshops and training courses for both professionals and local community members to investigate and transfer capacities aimed at adding values to Andean grains and nutritious millets and make them more competitive on the market. Strategic add value approaches have included the development of food recipes which blended traditions with innovative processing technologies.

- **Low cost processing technology:** Capability-building for local community, particularly women in using grain processing mills to do away with the drudgery associated with the traditional method of milling has been carried out in India in 2002. Participants have been trained by food processing experts from University experts on grain malting, milling, flour processing and blending for preparation of various food items to promote consumption of millets as home food, school meals and healthy foods.

Strengthening partnerships and capacities

Safeguarding the resource base of neglected and underutilized species requires concerted actions among all stakeholders. Local people and farmers will be the most important actors in reversing the decline in use and arresting the genetic erosion of NUS. However, they will need to be supported by others. Building capacities and partnerships among all the stakeholders at national, regional and International levels in both the formal PGR institutions and the civil society organizations is hence a key element in IPGRI's work. Within this domain of efforts, IPGRI promotes partnerships through an innovative holistic "filiere" approach, meant to link traditional PGR actors (gene bank operators, germplasm scientists, breeders, etc.) with production-to-use actors and policy makers in order to realize economic development using NUS genetic resources in a more concrete and sustainable way (fig 1).

Relevant examples from IPGRI's activities in this domain:

- **Analyses of production-to-use chains:** These were carried out along with cost-benefit studies on commercialization and marketing of Andean grains in Ecuador and Peru.
- **Strengthening agricultural assistance programs:** Courses on more efficient agronomic operations have been carried out in India, Nepal and Latin America.
- **Strengthen operational links in "filiere":** Local and regional fairs for Andean grains to strengthen networking at local level were organized in Bolivia Ecuador and Peru in 2002. These events proved to be very useful occasions to consolidate networking among farmers and representatives of the private sector. Meetings with private enterprises to discuss value-added strategies to improve local markets of Andean grains took place in Bolivia in 2002.
- **Mobilization of local authorities:** Local workshops with representatives of Municipalities to discuss on strategies for Andean grain products promotion were organized in Bolivia in 2002. These meetings contributed to also raise awareness on the nutri-

tional values of Andean grains and canvass additional support of local authorities for these crops.

- **Establishment of "Self Help Groups" (SHGs):** Village communities in India have been organized as SHGs to promote nutritious millets cultivation, processing, value addition and marketing. SHGs will be playing a critical role in capacity building interventions and capital supply through micro-credit and other income generation initiatives in support of community members.
- **Empowerment of local processors:** The establishment of community-based enterprises to process effectively Andean grains was pursued by IPGRI's partners in Bolivia in 2002.
- **Woman workshops:** Women play a fundamental role in processing NUS (Guarino, 1997; IPGRIa, 2002) and their capacitation in the area of food preparation is hence most strategic to enhance the use of these species. IPGRI has been supporting several courses targeting specifically women in Latin America (focusing on Andean grains), India and Nepal (focusing on nutritious millets), where participants improved their own skills in product transformation, value-adding preparations, and nutrition enhancement.
- **Capacitating agricultural students and technicians:** Development of training material to capacitate students in cultivation and post harvest practices took place in Bolivia in 2002 and 2003: 139 students have been trained in the area of germplasm collection of Andean grains.
- **Strengthening capacities at University level:** On-the-job training of graduate and post graduate students is a priority in IPGRI's Agenda (IPGRI 1999). Recipients of IPGRI's recent support include students of Ecuador and Bolivia working on Andean grains and students from Syria and Turkmenistan working on pomegranate genetic resources.

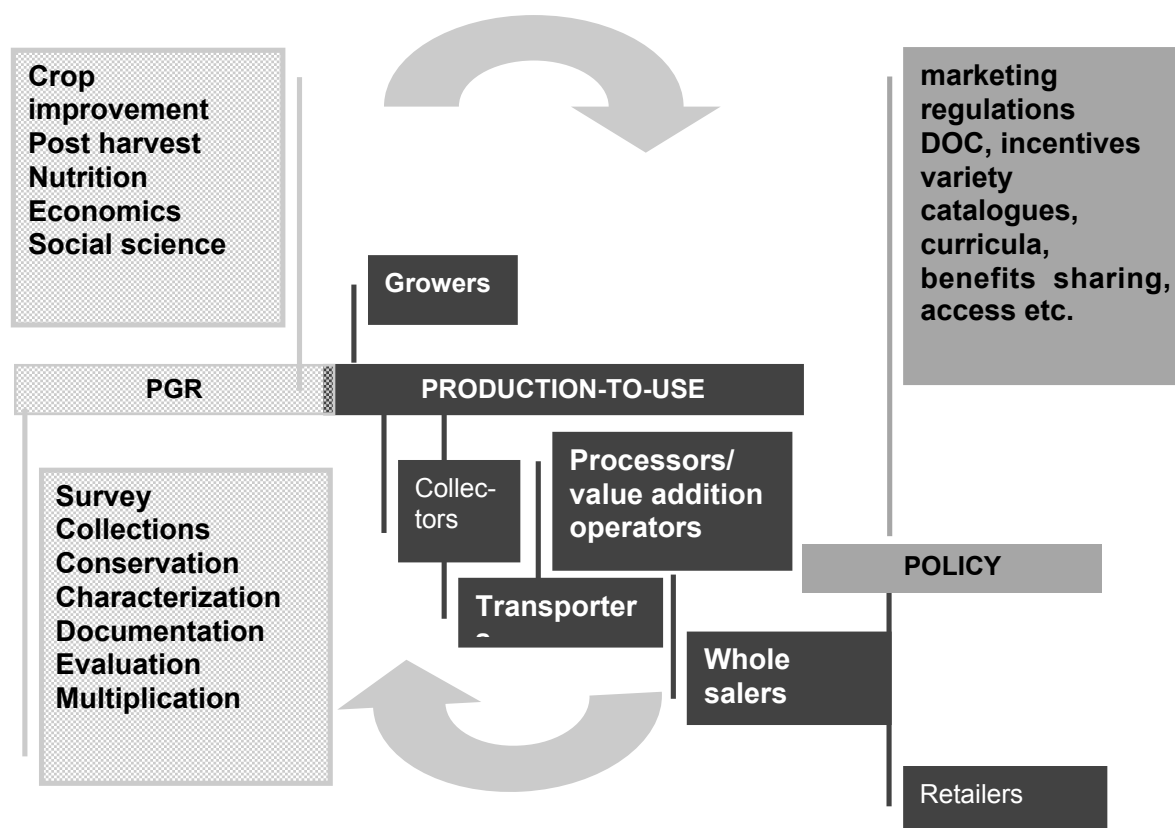


Fig.1 The holistic "filier" approach in addressing sustainable conservation and use of neglected and underutilized species.

Developing effective policies and raising public awareness

These two domains are very strategic in enhancing the use of NUS particularly in the medium-long term period. Better policies and legal frameworks are required to support the research, cultivation and commercialization of neglected and underutilized species. As these species are developed and exchanged, efforts are needed to promote policies, laws and regulations that return benefits from increased use of NUS to the communities that have been custodians of both the genetic resources and the associated knowledge. Raising interest in NUS is similarly fundamental to creating a more favourable environment for their sustainable production and use. Policy-makers, research institutions, the private sector and users at large need to be made aware of the concrete benefits that arise from a better use of these species and should be encouraged to share efforts on common socio-economic goals.

Relevant examples from IPGRI's activities in these two domains include:

- **Promoting greater access to NUS germplasm:** IPGRI has been actively engaged in the discussions over the possibility to include NUS species in the list of the FAO International Treaty on Plant Genetic Resources for Food and Agriculture adopted by the FAO Conference on 3 November 2001 (Padulosi, 2000).
- **Promotion of NUS in Media:** A video made by Channel One of the Austrian TV (ORF) on NUS was realized and broadcasted in 2002. A TV Program focusing on nutritional values of millets was aired in India in 2002. Short videos on values of Andean crops and nutritious millets were produced and made available to communities and media. Newspaper articles in several local and national press were published in conjunction with fairs, workshop and other events organized by IPGRI's partners in Latin America and Asia and North Africa. Radio interviews have been carried out in several countries at regular intervals to highlight the importance of

NUS in income generation and nutrition. Articles in newsletters, posters, fact sheets in national and local languages have been also regularly produced to promote NUS at different levels. An internet web page on NUS that contains public awareness articles is also maintained by IPGRI.

- **Farmer workshops:** 6 farmer workshops addressing the cultivation and marketing of Andean grains were organized in Ecuador in 2002.
- **Crop festival:** An amaranth festival has been organized in Peru in 2002 to promote the cultivation and consumption of this and other nutritional-rich Andean grains.
- **Exhibitions:** A typical-food products exhibition was held in Peru in 2002 and attended by 48 organizations.
- **Food competition:** A competition for best food preparations using cañihua was organized in Peru in 2002. This event was attended by more than 60 participants and contributed to raise the awareness on the nutritional value of this crop within local communities.

The way forward

The work carried out by IPGRI and its partners on neglected and underutilized species provided so far clear indications that there is ample scope to enhance the use of these species. Critical in achieving this goal, is however the role played by sustainable conservation, technology transfer and human resources development. Experiences from IPGRI's portfolios of projects on NUS have shown that these instruments can be successfully developed and applied through effective partnership among all stakeholder groups.

Working with local communities around the world has shown that transfer of innovative practices is a dynamic process and adoption requires time. To that end, fine-tuning with existing practices is seen an important step to facilitate the whole adoption process.

Progressive farmers, producers and simple users play an important role in promoting innovation and fostering partnership with researchers (Friis-Hansen and Sthapit. 2000). Their participation should be encouraged during the implementation of project activities as well as in community events such as diversity rich fairs and cooking competitions.

An integrated inter-sectoral approach along the production-to-use filiere is fundamental to realize a durable, and effective income generation. Efforts should continue to move towards what we defined a holistic "filiere", which brings closer all actors, from genetic resources

experts, growers, post harvest, add value operators to policy makers and the whole public opinion at large, which need to be continuously sensitized over the role played by NUS. Working towards the increase of demand and not just the offer is indeed essential to promote NUS in a sustainable manner.

Greater efforts at national level are needed to link the various sectors of the society - currently not effectively harmonized- into a common framework for pursuing the promotion of NUS. For instance, successful complementary conservation and use methods, in order to be fully effective, require close cooperation between the Ministry of Agriculture (largely involved in ex situ conservation and production of NUS) and the Ministry of Environment (traditionally involved in in situ conservation). Furthermore, efforts to involve the active participation also of other Ministries and Research Institutions, not directly involved in Agrobiodiversity conservation activities (s.a. The Ministry of Tourism, Ministry of Health, Ministry of Education, Ministry of Commerce etc), are also necessary for bringing about a long term sustainability and important synergies in our efforts.

Build up capacities at community level in the area of "market Intelligence" to support NUS enhancement initiatives is also highly recommended. The feasibility of the establishment of a CBD-linked fair-trade mechanism that would support marketing and commercialization of NUS could be also explored.

References

- Arora, R.K. and Anjula Pandey. 1996. Wild Edible Plants of India: Diversity, Conservation and Use. National Bureau of Plant Genetic Resources, New Delhi, India.
- Bhag Mal. 1994. Underutilized grain legumes and pseudocereals. Their potentials in Asia. Regional Office for Asia and the Pacific (RAPA). Food and Agricultural Organization of the United Nations (FAO), Bangkok, Thailand.
- Cowling, Wallace A., Bevan J. Buirchell and Mario E. Tapia. 1998. Lupin. *Lupinus L.* Promoting the conservation and use of underutilized and neglected crops. 23. Institute of Plant Genetics and Crops Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome, Italy.
- Edmonds J.E. 1990. Herbarium survey of African *Cochorus L.* Species. Systematic and Ecogeographic Studies on Crop Genepools. 4. International Plant Genetic Resources Institute (IPGRI), Rome, Italy.
- 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, Ger-

- many, 17-23 June 1996. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Friis-Hansen, E. and B. Sthapit. 2000. Participatory approaches to the conservation and use of plant genetic resources. International Plant Genetic Resources Institute, Rome, Italy.
- Frison E., H. Omont and S. Padulosi. 2000. GFAR and International Cooperation on Commodity Chains. Synthesis paper presented at the GFAR-2000 Conference held in Dresden, Germany on 21-23 May 2000.
- Guarino L. (editor). 1997. Traditional African Vegetables. Promoting the conservation and use of underutilized and neglected crops. 16. Proceedings of the IPGRI International Workshop on Genetic Resources of Traditional Vegetables in Africa: Conservation and Use, 29-31 August 1995. ICRAF-HQ, Nairobi, Kenya. Institute of Plant Genetics and Crops Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome, Italy.
- Guzmán, J., F. Mamani and W. Rojas. 2002. Fairs of germplasm exchange of cañahua and quinoa among rural communities. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Species. Fundación PROINPA, La Paz, Bolivia (in Spanish).
- Hadj-Hassan, A., S. Padulosi, N. Al Batal, A Jawad and Y. Hadj-Hassan. 2003. Study of laurel tree for ornamental, alimentary, medicinal and aromatic uses. IPGRI-University of Aleppo-Syrian Supreme Council of Science Symposium on neglected and underutilized plant species: current and future prospects. University of Aleppo, Syria. 6-8 July 2003 (in press).
- Hong, T.D., S. Linington and R.H. Ellis. 1996. Seed Storage Behavior: a Compendium. Handbook for Genebanks: No. 4. International Plant Genetic Resources Institute, Rome, Italy.
- INIA, 2002. Characterization and diversity fair for cañahua in Kelluyo, Pomata, Lampa, Cupi, Macari and Huancane Communities of Peru. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Species. CIRNMA, Puno, Peru (in Spanish).
- IPGRI 1999. Diversity for development. The New Strategy of the International Plant Genetic Resources Institute. IPGRI, Rome, Italy.
- IPGRI 2002a. Neglected and Underutilized Species: Action Plan of the International Plant Genetic Resources Institute. International Plant Genetic Resources Institute, Rome, Italy.
- IPGRI 2002b. Descriptors for Rocket (*Eruca* spp.) International Plant Genetic Resources Institute, Rome, Italy.
- Johnson R.C. and T.Hodgkin 1999. Core collection for today and tomorrow. International Plant Genetic Resources Institute, Rome, Italy.
- Kaddoum N., Noun J., Padulosi S. and Bari A., 2001. Chicory: a valuable neglected plant of Lebanon and its potential use. In Symposium on Diversity of Ecosystems & Genetic Resources in Syria and Lebanon. Al Basel Conference Hall, Ministry of High Education, Damascus, 4-5 February 2001, p: 18.
- Knudsen, H. 2000. Directorio de Colecciones de Germoplasma en América Latina y el Caribe. Primera Edición. International Plant Genetic Resources Institute (IPGRI), Rome, Italy.
- Laliberté B, L. Withers, A. Alercia and T. Hazekamp. 1999. A synthesis of findings concerning CGIAR case studies on the adoption of technological innovations. In L. Sechrest, M. Stewart and T. Stickle editors. CGIAR-IAEG Secretariat. FAO, Rome, Italy.
- Maxted, N. 1995. An ecogeographical Study of *Vicia* subgenus *Vicia*. Systematic and Ecogeographic Studies on Crop Gene pools. 8. International Plant Genetic Resources Institute (IPGRI), Rome, Italy.
- Mazon, N., E. Peralta, M. Rivera and J. Pinzon. 2002. Rejuvenation and characterization of quinoa and amaranth germplasm. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Species. INIAP, Quito, Ecuador. (in Spanish).
- Mnzava N.M., J.A. Dearing, L.Guarino and J.A. Chwaya (compilers) and H.De Koeijer (editor). 1999. Bibliography of the genetic resources of traditional African vegetables. Neglected leafy green vegetable crops in Africa Vol. 2. International Plant Genetic Resources Institute, Rome, Italy.
- Noun J.R. and N. Kaddoum. 2001. Essai de mise en culture d'écotypes de ~~Ciblotés~~ du haut bassin versant du fleuve de Damour et comparaison avec quelques variétés cultivées. In: Annales de Recherche Agronomique, 3: 167-175. University of Saint Esprit, Kaslik (USEK), Beirut, Lebanon.
- Noun J.R., C. Girard, S. Padulosi and A. Bari. 2001. Ethnobotanical and agro-ecological evaluation of neglected underutilized non-woody spontaneous species of Lebanon. In Symposium on Diversity of Ecosystems & Genetic Resources in Syria and Lebanon. Al Basel Conference Hall, Ministry of High Education, Damascus, 4-5 February 2001, p 19.
- Noun J.R., S. Padulosi, C. Girard and A. Bari. 2002. Méthode de recherche des sites et caractéristiques agro-écologiques de 4 espèces alimentaires (non ligneuses) sous-utilisées au Liban. In: Cahiers Agricolture. In press.
- Noun J.R. 2003. Agro-ecological, socio-economic and ethno-botanical study of underutilized non-woody Lebanese species: case studies on *Origanum syriacum* L.; *Salvia fruticosa* Miller, *Gundelia tournefortii* L. and *Cichorium intybus* L. PhD thesis. Institut National Agronomique Paris-Grignon (IN-APG), Paris, France. pp. 321.
- Pacosillo V. and B. Chura. 2002. Processing practices and products production from cañahua and quinoa at family level. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Spe-

- cies. Fundación PROINPA, La Paz, Bolivia (in Spanish).
- Padulosi S. and D. Pignone. 1997. Rocket: an old Mediterranean crop for the world. Report of the II International Workshop on Rocket 13 December 1996, Padova, Italy. International Plant Genetic Resources Institute, Rome, Italy.
- Padulosi S. 1999a. Criteria for priority setting in initiatives dealing with underutilized crops in Europe. In Gass, T., Frese, F. Begemann and E. Lipman, compilers "Implementation of the Global Plan of Action in Europe – Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Proceedings of the European Symposium, 30 June-3 July 1998, Braunschweig, Germany. International Plant Genetic Resources Institute, Rome.
- Padulosi S. (editor). 1999b. Priority setting for underutilized and neglected plant species of the Mediterranean Region. Report of the IPGRI Conference, 9-11 February 1998, ICARDA, Aleppo, Syria. International Plant Genetic Resources Institute, Rome, Italy.
- Padulosi S. 2000. A comprehensive vs. limited list of crops: the role of underutilized crops and opportunities for international centres, donor communities and recipient countries. Paper presented at the IAO Workshop on "Interdependence and food security: which list of PGRFA for the future multilateral system?". Istituto Agronomico per l'Oltremare, 1-2 October, Firenze, Italy.
- Padulosi S., T. Hodgkin, J.T. Williams and N. Haq. 2002a. Underutilized crops: trends, challenges and opportunities in the 21st Century. In "Managing plant genetic resources". J.M.M. Engels et al. Eds. 323-338 pg. CABI-IPGRI.
- Padulosi S. D. Leaman and P. Quek. 2002b. Challenges and opportunities in enhancing the conservation and use of medicinal and aromatic plants. *Journal of Herbs, Spices & Medicinal Plants*, Volume 9, Nos. 2/3 and 4: 243-268.
- Pareek O.P., Suneel Sharma and R.K. Arora. 1998. Underutilized Edible Fruits and Nuts: An Inventory of Genetic Resources in Their Regions of Diversity. IPGRI Office for South Asia. International Plant Genetic Resources Institute, Rome, Italy.
- Prohens J., A. Rodríguez-Burruezo and F. Nuez. 2003. New crops: an alternative for the development of horticulture. *Food, Agriculture & Environment* Vol.I(1): 75-79.
- Rojas W., M. Cayoja and G. Espindola. 2001. Catálogo de colección de quinua conservada en el Banco Nacional de Granos Altoandinos. Fundación PROINPA, La Paz, Bolivia.
- Rojas W., M. Pinto and A. Camargo. 2002. Regeneration and multiplication of cañahua and quinoa germplasm. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Species. Fundación PROINPA, La Paz, Bolivia (in Spanish).
- Rojas W. and S. Padulosi. 2003. Recipes of quinoa, kañawa, amaranth and lupin. Public awareness leaflets for the IFAD-IPGRI Project "Enhancing the Contribution of Neglected and Underutilized Species to Food Security and to Incomes of the Rural Poor". Fundación PROINPA, La Paz, Bolivia.
- Tapia, C. 2002a. Identification of microcenters of variability for quinoa, amaranth and lupin in Ecuador. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Species. INIAP, Quito, Ecuador (in Spanish).
- Tapia, C. 2002b. First fair on the conservation of Andean grains. In Technical Report of the IPGRI-IFAD Project on Neglected and Underutilized Species. INIAP, Quito, Ecuador (in Spanish).
- Vodouhè S. R. and Achigan Dako (Editors). 2003. Actes du Séminaire régional sur le Fonio: Renforcement de la contribution du fonio à la sécurité alimentaire et aux revenus des paysans de l'Afrique de l'Ouest. Badalabougou, Bamako, Mali. 19-22 novembre 2001. International Plant Genetic Resources Institute, Rome, Italy (in press).
- Williams J.T. and N. Haq. 2002. Global research on underutilized crops. An assessment of current activities and proposals for enhanced cooperation. ICUC. Southampton, UK.
- Yousef R. 2003. Assessment of the distribution, diversity and use of pomegranate in Syria. M.Sc. Thesis. Faculty of Agriculture, University of Aleppo, Aleppo, Syria (in Arabic).
- Zhang Z. and R.C. Johnson (compilers). 1999. Saf-flower germplasm collection directory. IPGRI Office for East Asia. International Plant Genetic Resources Institute, Rome, Italy.