Neglected and Underutilized Crop Genetic Resources for Sustainable Agriculture*

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The world is presently over-dependent on a few plant species. Diversification of production systems by including a broader range of species can contribute significantly to improved health and nutrition, livelihoods, household food security and ecological sustainability. Hundreds of little known traditional, neglected and underutilized plant species help support the lives of rural people by providing food, fodder, fibre, medicine, fuel wood, and shelter and nutrition benefits especially to women and children. Being low input crops, these are important for agricultural diversification and provide a unique opportunity to combat food and nutritional insecurity within the communities. This review paper highlights the importance of neglected and underutilized species, their role in crop diversification and reducing hunger, research efforts made at the national and international level, and future thrusts for germplasm collection, characterization, conservation, utilization, capacity building and the policies enabling their enhanced role in agricultural production and well being of the people.

Key Words: Neglected, Underutilized, Sustainable, Crop diversification, Characterization, Conservation, Enabling policies

Introduction

The dependence of mankind on plant resources is inevitable. Necessity based gathering of wild plants and their domestication have helped in the evolution of several useful plant species since the dawn of agriculture. Living in close contact with nature, man has learnt to use plants for food, fodder, medicine and other purposes. Out of the global wealth of about 80,000 edible plants, only 3,000 plant species have been used for food and only about 150 species have been commercially cultivated of which about 30 species provide 90% of the world's food (NAS, 1975a; Paroda, 1988). Three crops, namely, rice, wheat and maize provide more than half of the world's calorie requirements. Dependence on a few species involves a high degree of risk of loosing their genetic diversity due to various biotic and abiotic stresses. Hence, there is an urgent need for focused attention on exploiting alternative plant species for food and other purposes in order to widen the food basket to ensure adequate food supply, better nutrition and health to the people.

Underutilized crops are plant species traditionally used by many communities for food, fibre, fodder, oil, medicines and also for several other potential uses. These species are known by various names, e.g. underutilized, underdeveloped, underexploited, minor, lesser known, orphan, new, alternative, traditional, niche, neglected, forgotten, vanishing, lost crops and life saving/support species. Traditionally, these species contribute significantly to the well being and livelihoods of rural households. Many of these species form part of subsistence farming systems, while others are valued for their medicinal uses. Many of these occur in extreme environments and marginal or waste lands, and are being lost through rapid destruction of natural habitats, especially in the tropics.

Underutilized plants, often well adapted to marginal and stress conditions, constitute the lesser known species in terms of trade and research. Generally, they have high nutritional and industrial importance and are useful to humankind in various ways. Their cultivation is restricted to specialized geographical pockets in different agroecological regions, mainly by poor farming communities which derive their sustenance and livelihood from such plants. However their commercial importance and market value is still unknown to the public. Therefore, research on underutilized crops holds promise to attain sustainability, profitability and diversification in agriculture and to restore the balance of trade, reduced dependence on imports and to become more competitive in agricultural exports since our depleting resource can be replaced with renewable ones.

The underutilized plant species of economic importance are the key to sustainable agriculture in most of the developing countries facing resource constraints as well as rapid depletion of natural resources due to ever-increasing population pressure. Poverty at both rural and urban level leads to various health and nutritional problems, respectively. This can be improved upon

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through wider cultivation and inclusion of underutilized crops in our food habit. Food and Agriculture Organization of the United Nations (FAO) statistics revealed that about 800 million children, women and men suffer from protein-caloric under-nutrition, while over 2 billion suffer from hidden hunger and there is a high frequency of low birth-weight children caused by the deficiency of micronutrients in the diet, particularly iron (Swaminathan, 1999).

Wealth of Less Known Plants

Well documented information is available on genetic resources of less known cultivated food plants (Arora, 1985; Paroda and Bhag Mal, 1989). The genetic diversity in the underutilized and underexploited food plants is represented by native species as well as naturalized alien species, viz., 15 species for seed/nut crops, 21 for vegetable crops, 10 for roots and tubers, 25 for fruit crops, and 10 species for other useful plants as listed below:

Seed/nut crops: The important species that need to be paid attention are *Amaranthus* spp., *Borassus flabellifer*, *Chenopodium* spp., *Coix lacryma-jobi*, *Digitaria cruciata* var. *esculenta*, *Echinochloa colonum*, *Euryale ferox*, *Mucuna capitata*, *Panicum sumatrense*, *Parkia javanica* and *Paspalum scorbiculatum*.

Pulses: The important underutilized pulse crops include *Dolichos uniflorus*, *Psophocarpus tetragonolobus*, *Vigna aconitifolia*, *V. angularis*, *V. umbellata* and *V. trilobata*.

Oilseeds: The important species which need to be paid attention are *Amoora rohituka*, *Azadirachta indica*, *Aesandra butyracea*, *Calophyllum inophyllum*, *Juglans regia*, *Madhuca latifolia*, *Pongamia pinnata*, *Prinsepia utilis*, *Salvadora oleoides*, *Schleichera oleosa*, *Shorea robusta* and *Terminalia catppa*.

Vegetable crops: Amongst these crops, there are two distinct categories: i) plants whose leaves/young shoots are eaten cooked or used in making soups and ii) plants whose tender fruits/pods are consumed as vegetable after cooking. The important species are *Amaranthus polygonoides*, *Bambusa tulda*, *B. spinosa*, *B. vulgaris*, *Canavalia polystachya*, *Corchorus capsularis*, *Crambe cordifolia*, *Dendrocalamus asper*, *Emilia sagitata*, *Houttuyina cordata*, *Lactuca indica*, *Moringa oleifera*, *Mucuna cochinchinensis*, *M. utilis*, *Nasturtium indicum* var. *apetala* and *Wolfa arrhiza*.

Root and tuber crops: Most of these are consumed after boiling – the tubers are usually eaten after cooking and occasionally consumed raw. The useful species are *Allium tuberosum*, *Alocasia cucullata*, *Asparagus sarmentosus*, *Coleus forskohlii*, *Colocasia esculenta*, *Curcuma angustifolia*, *Eleocharis tuberose*, *Moghania vestita*, *Netumbo nucifera* and *Pachyrrhizus erosus*.

Fruit crops: The important lesser known cultivated fruit species identified are *Aegle marmelos*, *Artocarpus lakoocha*, *Carissa congesta*, *Citrus* species, *Elaeocrpus floribundus*, *Emblica officinallis*, *Garcina pedunculata*, *G. tinctoria*, *Grewia asiatica*, *Limonia acidissima*, *Malpighia coccigera*, *Morus alba*, *Pereskia grandifolia*, *Phoenix sylvestris*, *Phyllanthus distichus*, *Rhodomyrtus tometosa*, *Rubus albescens*, *R. ellipticus*, *Syzgium cuminii* and *Zizyphus mauritiana*.

Spices, condiments and beverage plants: The more important species are *Amomum aromaticum*, *A. xanthioides*, *Anethum sowa*, *Areca triandra*, *Caryota urens*, *Euterpe edulis*, *Kaempferia galanga*, *Madhuca indica*, *Osmanthus fragrans* and *Piper longum*.

Fodder and fodder-cum-fuel species: *Agrostis alba*, *Albizia lebbek*, *Desmodium parvifolium*, *Gliricidia sepium*, *Hardwickia binata*, *Indigofera heterantha*, *Kochia indica*, *Leptochloa fusca*, *Polygonum tortuosum*, *Potentilla fruticosa*, *Prosopis cineraria*, *Rhyncosia minima*, *Rivea hypocrateriformis*, *Salvadora persica* and *Zizyphus nummularia*.

Dye yielding plants: *Butea monosperma*, *Kochia indica*, *Wrightia tinctoria*, *Morinda citrifolia* and *Anogeissus pendula*.

Tannin yielding plants: *Acacia nilotica* and *Cassia auriculata*.

Plants used as detergents: *Roots and leaves of Euphorbia thomsoniana*, *Lychnis indica* and *Silene griffithii*.

Gum, wax and resin plants: *Acacia senegal*, *A. nilotica*, *Butea monosperma*, *Commiphora wightii*, *Prosopis juliflora*, *P. cineraria*, *Moringa oleifera* and *Salvadora oleoides*.

Timber and fuel plants: *Acacia jacquemontii*, *A.nilotica*, *A. senegal*, *Calligonum polygonoides*, *Capparis decidua*, *Dalbergia sissoo*, *Azadirachta indica*, *Cordia dichotoma*, *C. gheraf*, *Moringa oleifera*, *Tecomella undulata* and *Boswellia serrata*.

Fibre plants: *Leptadenia pyrotechnica*, *Crotalaria burhia*, *Saccharum munja*, *S. bengalense*, *Calotropis procera*, *C. gigantea*, *Cordia dichotoma*, *Acacia leucophloea*, *Butea monosperma*, *Sida cordifolia*, *S. carpinifolia* and *S. rhombifolia*.

Role of Underutilized Crops

Crop Diversification

The focus of research and development on a few widely used species has helped in meeting the food needs of the rapidly growing human population, but it has narrowed down dramatically the number of species upon which global food security and agricultural incomes depend. The impact of the narrowing species base of global food security is likely to be felt most by the rural poor, particularly in marginal areas where people are faced with a restricted set of livelihood options. With the increasing speed and intensity of social and environmental change, humankind has become more vulnerable now than ever before. Urgent measures for crop diversification need to be taken to promote a wider diversity of crop species to ensure food security and enhanced incomes of the poor.

Many neglected and underutilized species occupy important niches, adapted to the risky and fragile conditions of rural communities and have a comparative advantage in marginal lands where they have been selected to withstand stress and to contribute to sustainable production with minimal inputs. They also contribute to the diversity and the stability of agro-ecosystems and are potential crops for the diversification of agriculture. These species also often have a strategic role in fragile ecosystems, such as those of arid and semi-arid lands, mountains, steppes and tropical forests. To address the needs of these ecosystems, it is imperative to broaden the focus of research and development by including a much wider range of crop species, with the ultimate objective of increasing their sustainable productivity.

Ethnobotanic surveys confirm that hundreds of such species are still to be brought under cultivation in many countries, representing an enormous wealth of agrobiodiversity having the potential to contribute to improved incomes, food security and nutrition. These locally important species generally remain neglected which can lead to genetic erosion of their diversity and usefulness, thus restricting development options for the rural poor. Many of the species ignored for research and development are rich in cultural value. Local communities consider these as essential elements not only in their diet but also in their food culture and rituals. The link between cultural values and plant resources can be important in empowering communities to conserve and develop their biological and cultural assets.

Most of the underutilized crop species do not require high inputs and can be successfully grown in marginal and degraded lands and at the same time can contribute to increased agricultural production, enhanced crop diversification and an improved environment. In addition, such efforts will help in conserving and using the genetic resources of underutilized crop species.

Combating World's Hunger

The member countries of the United Nations (UN) pledged to meet by 2015 a set of international targets known as United Nations Millennium Development Goals (MDGs). The first MDG is to reduce by half the number of people who suffer from hunger. The current focus on just a few crops means there is a strong chance that the global community will miss the first UN Millennium Development Goal (MDG) on hunger by several decades beyond 2015. Hence, the national development plans should make better use of agricultural biodiversity and there should be a better access to traditional foods.

Neglected and underutilized plant species can play a very significant role in reducing hunger the world over. Realizing this, an International Consultation was organized at Chennai in April 2005 by M.S. Swaminathan Research Foundation (MSSRF), Chennai, India and Bioversity International (formerly, the International Plant Genetic Resources Institute – IPGRI) and Global Facilitation Unit for Underutilized Species, both based in Rome, Italy. The main outcome of the Consultation was the adoption of Chennai Platform for Action which is a 10-point strategy, designed to assist the national governments and international agencies to achieve, as soon as possible, the UN MDGs of reducing extreme poverty and hunger by half by 2015. During the consultation, it was emphasized that eradicating hunger will require more research on nutritious but largely ignored crop species. The farmers in developing countries should be encouraged to grow a wider range of native crops to provide local populations with greater dietary diversity. These crops could include varieties of pseudo-cereals, millets and pulses in Asia, tubers and grains such as quinoa, canihua and amaranth in the Andes region of South America; and green leafy vegetables in Africa.

The world increasingly relies on a shrinking food basket of a few crops to fulfill the dietary needs of its people. Tackling malnutrition by increasing dietary diversity would not only help address this 'hidden hunger' but could also help achieve two more of the MDGs, namely, reducing infant mortality and reducing the number of women who die in childbirth (Swaminathan, 2006).

Interpreting the first MDG as meaning that each person gets more food, ignores the fact that malnutrition is also about people not getting enough of micronutrients, vitamins and minerals. Malnutrition contributes to at least half of the 10.4 million child deaths each year. Vitamin A deficiency, which can cause blindness, afflicts 120 million children every year, of whom 250,000-500,000 go blind. Some two billion people are anemic because of iron deficiency. In the past, these deficiencies were tackled through food fortification programmes, but these cannot be replicated in remote rural areas and the dietary diversity is the only way forward (Frison, 2006).

Research Achievements

National Efforts in India

India exhibits extreme diversity for edapho-climatic conditions, agroclimatic regions and ecosystems. The Indian sub-continent is a reservoir of several plant species, which have known uses of future potential for the benefit of human beings. India occupies a unique position among the major gene-rich countries of the world with a bounty of 49,000 species of higher plants known to occur. About 30% of these species–17,500 species are endemic (Gautam and Singh, 1998) occurring in 16 major vegetation types of the country.

Systematic efforts have been made to compile information on lesser known food plants including wild resources used by farmers and tribal communities in different regions of the country. Ethnobotanical investigations have been made to record a large number of wild plant species used by native tribal and aboriginal people, to meet their varied requirements (Jain and Sinha, 1987; MEF, 1994). Immensely rich landrace diversity occurs in major agri-horticultural crops, which is attributed to the farmers' conscious or unconscious selections, inherited and perpetuated over generations. Also, an enormous richness occurs in terms of crop relatives (326 species). Out of a rich floristic wealth of higher plants in the country, over 1000 wild food plants are used, and human association with these has been much older than with crops that emerged with settled agriculture (Arora, 1985; Arora and Pandey, 1996). Over 50 of these species have been domesticated by native communities. Others hold promise as nutritional food supplements for future domestication and exploitation.

In order to strengthen research on underutilized plants at the national level, an All India Coordinated Research Project on Underutilized Crops (AICRP-UUC) was initiated in 1984 with its headquarters at the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Under this programme, the priority underutilized crops were identified based on their suitability to the existing cropping systems or their potentiality to supplement the new production systems, and concerted research efforts were made in respect of germplasm collecting, characterization, evaluation, conservation and utilization of selected priority species particularly for crop diversification for food and commerce (Bhag Mal, 1988, 1993, 1994; Bhag Mal and Joshi, 1991; Paroda, 1988; Paroda and Bhag Mal, 1989, 1992; Phogat *et al.*, 2004)

Germplasm Collection, Characterization and Evaluation

Efforts through well-organized multi-crop explorations resulted in sizeable germplasm collections over the years in a few selected species. Under the World Bank funded National Agricultural Technology Project (NATP), priority areas for exploration were identified and germplasm of rice bean (*Vigna umbellata*), buckwheat (*Fagopyrum esculentum*), amaranths (*Amaranthus* spp.), scarlet bean (*Phaseolus multiflorus*) and bhanjira (*Perilla frutescens)*, were collected. Useful germplasm was also introduced from other countries through the National Bureau of Plant Genetic Resources (NBPGR), New Delhi which maintains links with over 70 countries.

In India, over 25,000 accessions of about 60 underutilized crops were introduced during the past 50 years out of which 3361 accessions of 21 crops were evaluated under the aegis of All India Coordinated Project (now a Network) on Underutilized Crops (Rathi *et al.*, 2005; Phogat *et al.*, 2006). Germplasm characterization and evaluation was also done at different research centres in several underutilized species, namely, amaranth (Joshi, 1986; Shukla and Singh, 2000; Verma *et al.*, 2001; Varalaxmi, 2004; Rana *et al.* 2005; Priya *et al.* 2007), buckwheat (Joshi and Paroda, 1991); rice bean (Seyie *et al.* 2006), winged bean (Pan *et al.*, 2005); moth bean (Bhavsar and Birari, 1989) chenopod (Bhargava *et al.*, 2004, 2005); horsegram (Birari *et al.*, 1987; Chahota *et al.*, 2005); and grasspea (Pandey *et al.*, 2000).

Germplasm Conservation

Conservation of germplasm of many neglected and threatened plant species assumes a high priority as the local rural populations inhabiting the extremely harsh environments depend on these crops. In view of large-scale over-exploitation of land resources, fragile ecosystems of the humid tropical and temperate forests

are under threat. In diversity-rich areas, conservation of such plant species assumes greater priority for current and future use. The conservation of plant genetic resources has been accomplished through: i) the farming community (*in situ* conservation through the continued use of local cultivars), and ii) conservation through the formal sector (*ex situ* conservation in the genebanks). Some of the potentially useful wild species have been domesticated and their cultivation initiated in areas where the climatic conditions are similar to the niche of wild species. Valuable germplasm of several neglected and underutilized plant species is maintained by NBPGR, at New Delhi as well as at its Regional Stations located in different ago-climatic zones of the country. Also, a few selected centres of AICRP (UUC) have been assigned the responsibility for maintaining the germplasm of particular species. The current status of germplasm holdings of important underutilized crops in India is given in Table 1.

Germplasm Utilization

The genetic diversity of a few selected native and introduced species has been successfully utilized in developing improved varieties through selection process. The germplasm available in different crops was evaluated for grain yield and other traits at several research stations/ centres and promising lines/cultivars were identified. The selected elite lines were tested through multi-location trials over the years and the most promising varieties were identified/released for cultivation in different agro-climatic zones. The varieties identified/released in grain amaranth (*Amaranthus hypochondriacus*), buckwheat (*Fagopyrum esculentum*), winged bean (*Psophocarpus tetragonolobus*), rice bean (*Vigna umbellata*), faba bean (*Vicia faba*), guayule (*Parthenium argentatum*) and jojoba (*Simmondsia chinensis*) are given in Table 2. Concerted breeding efforts have also been initiated in a few selected potential crops at specified research centres for developing better varieties. Hybridization programmes in amaranth , rice bean, adzuki bean (*Vigna angularis*) and tumba (*Citrullus colocynthis*) and mutation breeding programmes in rice bean, winged bean and tumba are currently underway at different research centres in the country.

International Scenario

Neglected and underutilized plant species play a significant role in crop diversification and sustained/ enhanced agricultural production (Bhag Mal, 1994; Williams, 1995; Padulosi, 1999). Much global awareness currently prevails among not only the researchers but equally among the planners, policy makers, growers and users all over the world about their usefulness and economic potential and concerted efforts in this direction

Table 1. Germplasm assembled and characterized in important underutilized crops**

Crop	No. of accessions	Major source countries	Origin
Amaranth(*Amaranthus* spp.)	4950	India, Russia, Germany, Kenya,, Netherland, Nigeria, Syria, Nepal, Bangladesh, China, Taiwan, USA	South America
Chenopod(*Chenopodium* spp.)	177	India, Poland, USA. Italy. Hungary, Russia	South America
Buckwheat(*Fagopyrum* spp.)	800	India, Nepal, Russia, Hungary, Germany, Japan	Central Asia Near Eastern Region
Winged bean (*Psophocarpus tetragonolobus*)	328	India, Ghana, Papua New Guinea, Nigeria, Indonesia, Philippines, USA, Thailand, Sri Lanka, Puerto Rico	Papua New Guinea
Rice bean (*Vigna umbellata*)	1880	Nepal, China, India, Indonesia, Brazil, Colombia, Costa Rica, Belgium.USA	Indo-Burma/SE Asia
Faba bean (*Vigna faba*)	564	USA, Italy, Germany, Israel, Spain, Syria	Southwest Asia, Near East, Mediterranean
Adzuki bean(*Vigna angularis*)	167	Belgium, Germany, Japan, Thailand, Colombia, USA	India, Japan, China
Bambara groundnut (*Vigna subterranea*)	196	Nigeria, India, Australia, UK	Western Africa
Jerusalem artichoke (*Helianthus tuberosus*)	11	France, USA, Canada, Netherland	North America
Guayule (*Parthenium argentatum*)	113	USA, Mexico, Spain.	Southwest America, Mexico
Jojoba (*Simmondsia chinensis*)	188	USA, Israel, Mexico	South-west America, Mexico
Euphorbia spp.	83	USSR, USA, Philippines, Mexico, Spain	South America
Jatropha spp.	29	India, Brazil, Ghana, Australia, Nigeria	Tropical America
Tumba (*Citrullus colocynthis*)	115	USA, USSR, Nigeria, Sudan, Egypt, Korea, Holland, Australia	Africa, India
Cuphea spp.	13	USA	South America Brazil to Argentina

** Source AICRP (Uniderutilized Crops); NBPGR

Table 2. Varieties released under All India Coordinated Research Project on Underutilized Crops**

Crop	Variety	Year of release/ identification	Economic product	Average yield (q/ha)	Important Characteristics	Recommended areas for cultivation
(1)	(2)	(3)	(4)	(5)	(6)	(7)
GRAIN AMARANTH						
1	Annapurna	1984	Grain	22.50	High grain yield, high protein (15%), drought tolerant, wider adaptability	Hilly region
2	GA-1	1991	Grain	19.50	High seed yield and drought resistant	Gujarat, Maharashtra
3	Suvarna	1992	Grain	16.00	Drought tolerant, high grain yield	Peninsular region (Karnataka, Orissa), Gujarat
4	PRA-1 (PRA 8801)	1997	Grain	14.50	High grain yield	Uttaranchal hills
5	PRA-2 (PRA 9101)	2000	Grain	14.50	High grain yield	Hilly region
6	GA-2	2000	Grain	15.50	High grain yield	Gujarat
7	PRA-3 (PRA 9401)	2003	Grain	16.50	High grain yield	Hilly region
8	IC 35407 (Durga)	2004	Grain	21.00	High grain yield, early maturing	North west hill zone comprising Himachal Pradesh and Uttaranchal states
9	BGA-2 (Kapilasa)	2005	Grain	13.26	High grain yield, early maturing	Karnataka, Orissa and Tamil Nadu
10	VL Chua 44	2006	Grain	13.20	Early maturing (110-120 days), escapes from leaf webber and has non-spiny bract for easy threshability	Hills of Uttaranchal
BUCKWHEAT						
11	Himpriya	1991	Grain	12.00	High grain yield, medium maturity *F. tataricum*	High altitude areas
12	VL Ugal 7	1991	Grain	8.00	Early maturing, moderate grain yield	Mid hills
13	PRB 9001 (PRB 1)	1997	Grain	12.00	High grain yield, medium maturity	Mid hills
14	Shimla B-1 (Himgiri)	2005	Grain	11.12	Early maturing (81-95 days)	Dry temperate region of Himachal Pradesh and J & K
15	Sangla B-1	2005	Grain	12.65	Medium maturity (104-108 days), high grain yield	Mid and high hills of Himachal Pradesh and Uttaranchal
WINGED BEAN						
16	AKWB-1	1991	Green pods	105.00	Dual purpose (seed and vegetable), high pod yield	All winged bean growing areas
FABA BEAN						
17	VH 82-1	1998	Grain	14.55	High grain yield, medium maturity	Northern plains
RICE BEAN						
18	RBL-1	1986	Grain	16.00	High grain yield, medium maturity, light green seeded, resistant to diseases and stored grain pests	Punjab
19	PRR-1	1995	Grain	15.00	High grain yield	Uttaranchal hills
20	PRR-2	1997	Grain	12.00	High grain yield, shining light yellow seed colour	North east and North west hilly areas
21	RBL-6	2000	Grain	13.33	High grain yield medium maturity, light green seeded, resistant to diseases and pests	Entire plain Zone
22	RBL 35	2003	Grain	11.65	Early maturing	Plains

(1)	(2)	(3)	(4)	(5)	(6)	(7)
23	RBL-50	2003	Grain	10.90	Dark green seeds	Plains
24	BRS 1	2003	Grain	14.50	Early maturing, high grain yield	Hills
KALINGADA						
25	Gujarat Karingada-1	2001	Seed and vegetable	10.00	High protein (18%), high oil content (37.1%), high TSS (3.4%)	Arid/semi arid areas of Gujarat
GUAYULE						
26	Arizona-1	1986	Rubber	13.50	Drought resistant, high rubber content (6%), medium vigour	Arid and semi arid areas
27	HG-8	1991	Rubber	15.00	High rubber content (7%), tolerant to root rot, vigorous growth	Arid and semi arid areas
TUMBA						
28	RMT 59 (Mansha Marudhara)	2004	Seed/oil	2.38	High fruit and seed yield	Rajasthan and Gujarat
JOJOBA						
29	EC-33198	1986	Oil	5.00	High seed yield, drought tolerant	Arid regions and coastal areas
KANKODA						
30	Indira Kankoda (RMF-37)	2006	Vegetable	15-20	High fruit yield	Chhatisgarh, Uttar Pradesh, Jharkhand, Orissa and Maharashtra
JATROPHA						
31	Chhatrapati (SDAUJ-1)	2006	Oil	4.00 (3rd year)	High seed yield, high oil percent	Gujarat, Orissa, Haryana and Maharashtra

**Source : *AICRP (Underutilized Crops); NBPGR*

have been made at the international level. Several international organizations such as the Overseas Development Agency (ODA, now Department for International Development (DFID), UK, Bioversity International (formerly, the International Plant Genetic Resources Institute (IPGRI), Rome, Italy, United States Agency for International Development (USAID), US Academy of Agricultural Sciences, International Centre for Underutilized Crops (ICUC), Southampton, UK and British Council encouraged research on underutilized species in order to broaden the range of plant species crop diversification. The National Academy of Sciences (NAS), USA brought out several important publications highlighting the importance of potential underutilized species (NAS, 1975a, b; 1979a, b). The NAS has also brought out a book 'Lost plants of the Incas'; its earlier contributions are well known in this field (Anonymous 1975). The Food and Agriculture Organization of the United Nations (FAO) gathered and documented useful information on underutilized grain legumes and pseudo-cereals through expert consultancies (Bhag Mal, 1994, 2000).

The Commonwealth Science Council (CSC), London, UK organized several international workshops to assess the role of underutilized crops and life support species. The CSC has also organized a workshop jointly with the National Bureau of Plant Genetic Resources (NBPGR) at New Delhi in 1987 and its proceedings were published and widely distributed (Paroda *et al.*, 1988). Further, an International Symposium on 'New Crops for Food and Industry' was organized at the Southampton University, Southampton, UK in September 1987 and its proceedings were published and widely distributed (Wickens *et al.*, 1989). These developments generated lot of renewed interest in this group of crops.

Bioversity International in collaboration with Institute of Plant Genetics and Crop Plants Research (IPR), Germany published crop monographs on physic nut (Heller, 1996), yam bean (Sorensen, 1996), coriander (Diederichsen, 1996), hulled wheat (Padulosi, *et al.*, 1996), Niger (Getinet and Sharma, 1996), pili nut (Coronell, 1996), safflower (Dajue and Hans-Henning 1996), chayote (Saade, 1996), Bambara groundnut (Heller *et al.*, 1997), breadfruit (Ragone, 1997), cat's whiskers (Chweya and Mnzava, 1997), tef (Ketema, 1997), oregano (Padulosi, 1997), sago palm (Flach, 1997), black nightshade (Edmonds and Chweya, 1997), traditional African vegetables (Guarino, 1997), carob tree (Battle and Tous, 1997), grass pea (Campbell, 1997), buckwheat (Campbell, 1997), peach palm (Mora Urpi *et al.*, 1997), aibika/bele

(Preston, 1998), chenopods (Pratap *et al.*, 1998), lupin (Cowling *et al.*, 1998) and Andean roots and tubers (Hermann and Heller, 1997). The major information covered in these monographs include crop description, taxonomy, origin and centres of diversity, plant properties, uses, genetic resources, breeding, production areas, ecology and agronomy, limitations, research needs and future prospects. Bioversity also supported work on less utilized crop genetic resources in East Asia.

In a global initiative, Bioversity International with funding support from the International Fund for Agriculture Development (IFAD) implemented a programme on 'Enhancing the contribution of neglected and underutilized species to food security and to incomes of the rural poor' during 2001-2005. The species included were millets in Asia (India, Nepal), medicinal and aromatic plants in Central West Asia and North Africa (Egypt, Yemen) and Andean grains in Latin America (Bolivia, Ecuador, Peru).The project was successful in: i) working with farming communities, ii) securing and making available the diversity of target crops, iii) improving agronomic practices, iv) reducing drudgery in processing, v) adding value to products, vi) conducting training and building capacity among stakeholder groups, vii) fostering establishment of self-help groups and cooperatives, viii) creating links among various actors in the value chain, ix) raising awareness at local, national and international levels. The project delivered very substantial value and proved to be of interest to the entire development community (Padulosi, 2006)

Based on the success of this initiative, IFAD further supported a three-year follow-up programme 'Empowering the rural poor by strengthening their identity, income opportunities and nutritional security through the improved use and marketing of neglected and underutilized species' started in 2007. This amply demonstrated that biodiversity is important for people's lives, and that one way of protecting biodiversity is by supporting the use and appreciation of plant species that are currently neglected and underutilized.

With funding support from the International Development Research Centre (IDRC), Canada, Bioversity International also implemented a project on dietary diversity in sub-Saharan Africa. The project made substantial contribution in linking traditional food and plant resources to health in urban and rural populations, creating awareness of the benefits of traditional leafy vegetables and providing a platform for discussion for inclusion of dietary diversity and traditional foods in the national policies (Maundu, 2006).The increased use of traditional leafy vegetables in sub-Saharan Africa has clearly established the links between dietary diversity, better nutrition and better health (Eyzaguirre, 2004; Maundu, 2005). The IFAD funded project on minor millets in India and Nepal also demonstrated close links between nutrition, health, conservation and biodiversity and exemplary impact of the project on peoples' well being (Padulosi, 2002; 2006).

The Global Facilitation Unit for Underutilized Species (GFU) which is an initiative of the Global Forum on Agricultural Research (GFAR), the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD), Bioversity International and the International Centre of Underutilized Crops (ICUC) was established in 2002 at Bioversity International, Rome, Italy with funding support from the German Federal Ministry for Economic Cooperation and Development (BMZ).GFU encourages wider deployment of underutilized species globally and supports activities on networking, sharing of experiences across regions, creation of synergies, capacity building, socioeconomic backstopping and serves as a platform for discussion, strategy development and cooperation.

The International Centre on Underutilized Crops (ICUC) was established in 1989 at Southampton, U.K. which moved to Colombo, Sri Lanka in 2005. The mission of the centre is to promote the use of underutilized crops for the benefit of humankind and environmental protection. ICUC established Underutilized Tropical Fruit Trees in Asia Network (UTFANET) in 1995 and a regional centre known as the Asian Centre for Underutilized Crops (ACUC) in 2003 (Anonymous, 2006). ICUC published several monographs on minor fruit crops, viz., tamarind (Gunasena and Hughes, 2000), ber (Pareek, 2001), safou (Kengue, 2002), baobab (Sidibe and Williams, 2002), *Annona* spp, (Pinto *et al.*, 2005) and Ndjanssang (Tchoundjen and Atangana, 2006). Several International Conferences had also been organized by ICUC in UK, Argentina, Malta, and Colombo in which the progress and achievements made in different underutilized crops in different countries were shared and the future plans made for their better utilization.

Neglected Crops – a Sustainable Option

In order to make the neglected and underutilized crops a sustainable option, there is a need for concerted action to conserve genetic diversity of these species and to make

better use of it to improve food security, nutrition and income for the rural poor in developing countries. Enhanced research efforts on traditional crops need to be made and the policies to preserve them be integrated into national development plans, and food and nutrition security programmes, especially those providing food aid and school meals. Getting neglected crops back on the menu is important and equally so is ensuring that the poor people get a fair share of any commercial benefits that arise from exploiting these genetic resources.

Undoubtedly, there is a need to broaden the range of plant species utilized by man. An untapped potential of species exists in the forests, grasslands, swamps, rivers, seas and even deserts of the world. This potential is, however, a diminishing resource, diminishing in the face of environmental degradation by human and livestock population pressures and the requirements for food and raw materials on which to survive. Consideration of factors, such as available diversity and its exploitation, cost of domesticating new species, environmental problems and likelihood of their incorporation in the farming systems tends to indicate the need for taking risks for the domestication of new species (Smith, 1988). There are only a few people or organizations prepared to take risks of this nature and even fewer who also have the resources required to make the necessary investment. The farmer himself is unlikely to be able to take the lead in developing a new crop. In such a situation, the Government or established Public Sector agencies should take the lead in research and development related to this category of plants. The resources needed for this type of innovative work need to be critically assessed as the new endeavours would be more demanding.

Another serious concern relates to the fact that no proper data base is available pertaining to these crops. The Bioversity International and Global Facility for Underutilized Crops (GFU), Maccarese, Rome, Italy and the International Centre for Underutilized Crops at Colombo, Sri Lanka need to make efforts to establish such a data base for information on neglected and underutilized plants that are considered potential in different countries.

Future Thrusts

It is imperative that required thrust needs be given to the neglected and underutilized plants for harnessing their potential for various purposes. In order to make these plant species an important component of existing farming systems, several useful suggestions given below are worth considering both at the national and international levels to overcome an array of existing constraints and to improve their cultivation prospects:

Germplasm Acquisition

- Ecogeographic surveys are required to collect data on existing collections and on the distribution of plant species to have a consolidated picture on the available genetic diversity. The areas having rich diversity of land races, primitive cultivars and wild relatives of specific crops need to be identified.
- Germplsam collecting needs to be done through well organized exploration programmes aimed at filling gaps in the collections with particular emphasis on collecting the material possessing specific desirable traits.
- Joint exploration and collecting need to be undertaken involving multinational teams to collect diversity of targeted potential underutilized crops of common interest to participating countries. These should be supported by the respective national governments as well as the concerned international organizations.
- The germplsam of important underutilized crops available in other countries should also be acquired through bilateral/multilateral exchange following standard material transfer agreement (SMTA).

Characterization, Evaluation and Documentation

- Crop descriptor lists, not available for many of the underutilized crops, need to be prepared on priority basis.
- The available germplasm in different crops need to be characterized for important traits and crop catalogues need to be brought out and made available to interested researchers and other users.
- Joint multi-locational evaluation of germplasm needs to be undertaken by the research institutes/centres both within and between countries so as to obtain more useful information based on genotype x environment interactions.
- There is a great need to document the indigenous knowledge (IK) and wisdom available with the communities relating to the traditional cultivation and use of underutilized species

Genetic Improvement

- Well organized breeding programmes based on carefully defined objectives with various end uses of specific underutilized crops should be initiated to develop high yielding and nutritive varieties.

- Greater emphasis needs to be given for developing suitable plant types possessing specific desirable traits to fit well in different cropping systems and to serve specific needs of the users.
- Development of appropriate varieties suitable for non-conventional seasons and areas without disturbing the cultivation of more commonly grown food and cash crops in the region needs to be taken up.
- The problem of antinutrition factors and toxic substances which adversely affect the taste and digestibility needs due consideration while developing new varieties of underutilized species.
- Basic studies which hitherto remained largely ignored in many underutilized species require urgent attention. The genetics of plant, fruit and seed characters needs to be studied

Conservation and Utilization

- The germplasm of different crops scattered at different centres needs to be assembled and conserved in the national seed genebank/field genebank for long-term conservation.
- There is also a greater need to develop and promote suitable mechanisms for sustainable maintenance of genetic diversity of underutilized crop species in the production systems.
- The adaptability studies need to be undertaken in order to find out suitable agro-climatic situations for efficient cultivation of different crops. Standardization of package of cultivation practices also needs to be undertaken.
- Concerted efforts are needed to promote the establishment of seed/grain banks at the level of farmers in the target communities.

Product Development and Marketing

- Utmost attention needs to be paid to post-harvest processing, value addition and product development so as to enable the farmers and communities to make effective use of potential underutilized species for crop diversification.
- There is a great need to establish strategic alliances with agencies and organizations that have experience in marketing, processing and product development of neglected and underutilized species.
- Efforts need to be made to identify opportunities to add value through improved processing methods and product development through low-cost technologies
- Greater emphasis needs to be given to establish market links to enable the farmers to sell their produce at reasonable price and enhance their income from the use of these species
- Identify ways to ensure that the nutritional contributions of selected underutilized species are recognized and integrated into state-level poverty reduction and nutritional programmes

Strengthening Partnerships and Capacities

- Thrust needs to be given to build and strengthen sustainable partnerships with all the stakeholders at national and regional levels and promote close collaboration with National Agricultural Research Systems (NARS), Non-Governmental Organizations (NGOs), Farmers' Organizations, Civil Society Organizations (CSOs), entrepreneurs, private sector and the international organizations.
- The existing collaboration between various stakeholders needs to be strengthened and the initiatives that have delivered relevant outputs at the field-level need to be further geared up.
- There is a great need to play a catalytic role for pooling the scattered efforts and limited resources to address priority actions for developing and conserving neglected and underutilized crops.
- A close collaboration between the researchers, administrators and officials of development departments needs to be established to realize full potential of neglected and underutilized crops.
- In order to popularize cultivation and use of these crops, there is a need for raising public awareness through meetings, demonstrations, fairs, food competitions, TV/radio programmes, newsletters and pamphlets, etc.
- Focused attention needs to be given to develop public-awareness activities for crops and products at local and national levels and integrate such work in development related-activities
- There is a strong need for human resource development and capacity building of stakeholder groups through training/ skill enhancement interventions at the level of farmers, community members, researchers and extension workers.

Enabling Policies

- An urgent attention needs to be given for promoting policies, laws and regulations that ensure benefits from increased use of underutilized crops to the communities particularly women and other disadvantaged members of the society

- There is an urgent need to critically review and address specific aspects of policies on crops and commodities to identify gaps in addressing issues relating to neglected and underutilized species.
- The policies and guidelines for safeguarding access of farmers to the genetic resources of underutilized species need to be developed/strengthened.
- Appropriate measures need to be taken up to integrate policies related to sustainable use of these species by poor farmers including policies related to safeguarding of traditional knowledge base of the farmers

The global struggle against poverty and hunger can not be overcome without national and international commitment. The neglected and underutilized crops hold great promise for overcoming this struggle owing to their varied uses and inherent potential to adapt to harsh edapho-climatic situations. These species can prove to be a boon in agriculture in the changing scenario emerging due to the climate change. Conservation, sustainable and equitable use of genetic resources of these crops is thus imperative for the well being of present and future generations and calls for urgent attention of all concerned to initiate/enhance actions as suggested.

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