Report of a Network Coordinating Group on Minor Crops

Ad hoc meeting -16 June 1999 - Turku, Finland

L. Maggioni, *compiler*

European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR)

IPGRI is an institute of the Consultative Group on International Agricultural Research (CGIAR)

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The International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organization, supported by the Consultative Group on International Agricultural Research (CGIAR). IPGRI's mandate is to advance the conservation and use of genetic diversity for the well-being of present and future generations. IPGRI's headquarters is based in Rome, Italy, with offices in another 15 countries worldwide. It operates through three programmes: (1) the Plant Genetic Resources Programme, (2) the CGIAR Genetic Resources Support Programme, and (3) the International Network for the Improvement of Banana and Plantain (INIBAP).

The international status of IPGRI is conferred under an Establishment Agreement which, by January 1999, had been signed and ratified by the Governments of Algeria, Australia, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Chile, China, Congo, Costa Rica, Côte d'Ivoire, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Greece, Guinea, Hungary, India, Indonesia, Iran, Israel, Italy, Jordan, Kenya, Malaysia, Mauritania, Morocco, Norway, Pakistan, Panama, Peru, Poland, Portugal, Romania, Russia, Senegal, Slovakia, Sudan, Switzerland, Syria, Tunisia, Turkey, Uganda and Ukraine.

Financial support for the Research Agenda of IPGRI is provided by the Governments of Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Estonia, F.R. Yugoslavia (Serbia and Montenegro), Finland, France, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Macedonia (F.Y.R.), Malta, Mexico, Monaco, the Netherlands, Norway, Peru, the Philippines, Poland, Portugal, Romania, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, the UK, the USA and by the Asian Development Bank, Common Fund for Commodities, Technical Centre for Agricultural and Rural Cooperation (CTA), European Union, Food and Agriculture Organization of the United Nations (FAO), International Development Research Centre (IDRC), International Fund for Agricultural Development (IFAD), International Association for the Promotion of Cooperation with Scientists from the New Independent States of the former Soviet Union (INTAS), Interamerican Development Bank, Natural Resources Institute (NRI), Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), Nordic Genebank, Rockefeller Foundation, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), Taiwan Banana Research Institute (TBRI) and the World Bank.

The European Cooperative Programme for Crop Genetic Resources (ECP/GR) is a collaborative programme among most European countries aimed at ensuring the long term conservation and facilitating the increased utilization of plant genetic resources in Europe. The Programme, which is entirely financed by the participating countries and is coordinated by IPGRI, is overseen by a Steering Committee (previously Technical Consultative Committee, TCC) composed of National Coordinators nominated by the participating countries and a number of relevant international bodies. The Programme operates through ten broadly focused networks in which activities are carried out through a number of permanent Working Groups or through *ad hoc* actions. The ECP/GR networks deal with either groups of crops (cereals, forages, vegetables, grain legumes, fruit, minor crops, industrial crops and potato) or general themes related to plant genetic resources (documentation and information, *in situ* and on-farm conservation, technical cooperation). Members of the Working Groups and other scientists from participating countries carry out an agreed workplan with their own resources as inputs in kind to the Programme.

Cover: Photographs (blueberry "Bluetta"; white currant "Zitavia"; raspberry "Heritage") by Giancarlo Bounous, University of Turin, Italy; reproduced courtesy of L'Informatore Agrario.

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Contents

Preface

During its seventh meeting (Braunschweig, Germany, 1998), the ECP/GR Steering Committee decided to establish a Network Coordinating Group to start activities within a Minor Crops Network.

The European Symposium on the Implementation of the Global Plan of Action in Europe (Braunschweig, Germany, 1998) also recommended setting priorities, establishing inventories and strengthening collaboration for the conservation and use of underutilized crops.

Following suggestions from the ECP/GR National Coordinators, a Minor Crops Network Coordinating Group was identified by the ECP/GR Secretariat (the list of members is given as Appendix II). A meeting of the Group was held in Turku, Finland, on 16 June 1999, to define the scope of the Network and to create a framework for collaboration. Terms of reference for the Network, as well as a first plan of action, were also proposed (Appendix I).

The present report collects a number of papers presented during the meeting, which focus on the genetic resources of different typologies of minor crops. These papers summarize the status of collaborating activities in Europe and offer a hint of the rich basket of 'minor' genetic resources existing in Europe.

This collection of papers is a first contribution from ECP/GR towards the compilation of existing information. A list of existing networks operating for the conservation and use of minor crops in Europe (page 3) is given in the article of S. Padulosi. The article by I. Batlle offers a list of experts/institutions working on minor fruits (page 23). Other useful inventories are given by K. Hammer (list of minor crop plants from Central Europe /Crops of middle european origin, page 38) and by M. Hulden (List of taxa used in Europe, page 49). The need to address the conservation of medicinal plants was presented by D. Baričevič and resulted in a proposal to establish a specific working group. This proposal will be elaborated further by the Minor Crops Network Coordinating Group, in collaboration with other partners in Europe.

It is hoped that the results of this meeting and the implementation of the proposed workplan will help to increase collaborative action on minor crops genetic resources in Europe.

Joint efforts: experiences and prospects

Stefano Padulosi
IPGRI Regional Office for Central & West Asia and North Africa, c/o ICARDA, P.O. Box 5466, Aleppo, Syria

Introduction

This meeting organised by ECP/GR represents an important contribution to advancing the agenda of the conservation and use of minor crops in Europe.

In the last decade there has been increasing recognition by the scientific community, policy makers and users at large, of the role played by minor crops for the well being of people worldwide. Such a role is only now being acknowledged (in spite of the fact that these crops have been used by people ever since agriculture began) due to various factors. These factors include: a better understanding of the value of biodiversity as a whole; increasing attention being paid to conserving agrobiodiversity through the enhancement of its use; increasing attention being paid to sustainability in agricultural production; the call for "innovative food" to diversify agricultural production; greater attention paid to the quality of our food; the possibility of using minor crops for cultivating marginal lands; and the availability of new technological tools (such as biotechnology) for crop improvement and food processing (Padulosi 1999a).

Calls for a change in the pattern of conservation and use enhancement, today limited to staple crops and other major commodities, are voiced throughout the world and are not only limited to Europe (FAO 1996). This communality of interest represents a considerable advantage for the world community. Cooperation is particularly valuable when the species' promotion needs are considered. For example, the transfer of technology for overcoming specific breeding and agronomic bottlenecks faced by minor crops is one of those needs that could be met through greater scientific cooperation. The importance of cooperation in this area of research has been reiterated in many fora, including the European Symposium held in Braunschweig, Germany (Gass *et al.* 1999) and the Meeting of the Global Forum for Agricultural Research (GFAR) held in Beijing, China in 1999. Participation of stakeholders in such partnerships should be as wide as possible, particularly with regard to the involvement of Non Government Organizations (NGOs) and farmers' associations, which play an important role in conveying users' needs and ensuring a bottom-up approach in these efforts.

A comment on the terminology used in this text. The term "minor crops" is perhaps an ambiguous one and there is a need to agree on its meaning in the context of this new initiative of ECP/GR. For instance, are we referring to minor crops in terms of their production ("minor" when compared with the total production of staple crops), are we looking at the total agricultural area covered by these species, the income generated through their cultivation and commercialisation, their presence in our diet, their level of research attention, their conservation status, etc.?

In this paper "minor crops" refers to the degree of attention paid by researchers, conservationists and the commercial sector to these species. This paper will thus refer to neglected and underutilized species as components of the broader basket of minor crops. The exact meaning of the terms "underutilized" and "neglected" as they are employed by IPGRI are given below for the sake of clarity.

- **Neglected crops** are grown primarily in their centres of origin or centres of diversity by traditional farmers. They are still important for the food security and livelihoods of local communities. While some species may be globally distributed, they tend to occupy special niches in the local ecology and production and consumption systems. These crops continue to be maintained by socio-cultural preferences and use

practices, however, they remain inadequately characterised, conserved and neglected by research and development.

- **Underutilized crops** are crops which were once more widely grown but are falling into disuse for a variety of agronomic, genetic, economic and cultural factors. Farmers and consumers are using these crops less because they are in some way not competitive with other crop species in the same agricultural environment. The decline of these crops may erode the genetic base, thus limiting the future development of their distinctive useful traits in crop adaptation and improvement.

Current initiatives on minor crops

The following is a brief analysis of current initiatives being carried out in Europe in the area of minor crops. Some examples of activities from other regions and those pursued by international organisations are illustrated for their relevance to the purpose of this meeting. The list is not meant to be exhaustive and covers those initiatives for which collaboration with European partners already exists at various levels and whose results could particularly benefit ECP/GR's new initiative on minor crops. Because of the great challenge to retrieve information on this subject at the national level, it is hoped that a more detailed survey will be pursued through the ECP/GR Network on Minor Crops.

Activities within Europe

International initiatives

Underutilized Mediterranean Species Project (UMS)

Lifespan	Launched in 1993 by IPGRI, the project ended in 1998. Follow-up initiatives are being pursued by IPGRI through its Regional Office for Central & West Asia and North Africa (CWANA), located in Aleppo, Syria.
Organisation	Coordination of the project carried out by IPGRI from 1993 to 1996 through its Regional Office for Europe in Rome and from 1997 to 1998 through its CWANA office in Aleppo, Syria.
Support	Italian Government, Department of Cooperation for Development, Ministry of Foreign Affairs.
Objectives	Enhancing conservation & use of underutilized Mediterranean species: ▪ Enhancement of the status of conservation of selected species; ▪ Assessment of crop variability; ▪ Establishment and promotion of collaborative networks; ▪ Rescue of local knowledge along with germplasm; ▪ Promotion of on-farm conservation activities; and ▪ Development of databases on the selected species.
Focus	Pistacia (wild and cultivated species), Hulled Wheat (*Triticum monococcum, T. dicoccum* and *T. spelta*), Rocket (*Eruca sativa, Diplotaxis* spp.), Oregano (*Origanum* spp.).
Participation	Informal participation among European, North African and other countries (such as Canada, Iran, India and USA).
Work carried out	Public awareness, *ex situ/in situ* conservation, germplasm characterisation and evaluation, descriptor lists, dissemination of information, databases on experts/conservation, prioritisation methodology for underutilized species, exchange of germplasm material and associated information.

Experiences	Promotion of cooperation across the Mediterranean and other regions; Strengthening the role of local stakeholders; Sustainability of activities on underutilized crops; Assessment of training needs; Address issues of plant genetic resource (PGR) access and promote sharing of material and scientific information; Raising public awareness at international and national level on underutilized species.
Further information	http://www.cgiar.org/ipgri/

Identification, Conservation and Use of Wild Plants in the Mediterranean Region (MEDUSA Network)

Lifespan	Began in 1996.
Organisation	Coordinated by Mediterranean Agronomic Institute of Chania (MAICh), Chania, Greece.
Support	Directorate General I (EU), Centre International de Hautes Etudes Agronomique Méditerrannéennes (CIHEAM) / MAICh.
Objectives	Contribute to social and economic development of rural areas of the Mediterranean region through ecologically based management systems, sustainable use and conservation of local plant genetic resources.
Focus	Wild food and non-food species: ▪ Identification of valuable plant genetic resources; ▪ Regional information system to cover broad info on the species including marketing, indigenous knowledge, etc.; ▪ Assess conservation status and evaluate potential as alternative crops.
Participation	European, North African and West Asian countries.
Work carried out	Comprehensive documentation of plant genetic resources Networking; Establishment of a Mediterranean database for underutilized species; Training activities.
Experiences	Cooperation across the region; Public awareness at policy making level; Synergism with Food and Agriculture Organization; Stimulate greater involvement of National Agricultural Research Stations around the Mediterranean.
Further information	http://www.maich/medusa

Conservation, evaluation, exploitation and collection of minor fruit tree species (EU-GENRES 29 Project)

Lifespan	1994-1998.
Organisation	Coordinated by the University of Florence, Italy.
Support	EU through its Regulation 1467/94.
Objectives	Enhance the conservation and use of minor fruit trees in Europe.
Focus	Fig, loquat, persimmon, pomegranate, prickly pear, quince, European chestnut, pistachio, carob, azerole, medlar, nespilus, arbutus, cornelian cherry, jujube, sorb, mulberry.

Participation	11 European countries.
Work carried out	• Germplasm collection; • Conservation; • Evaluation; • Descriptor lists; • Inventory; • Database.
Experiences	Enhance cooperation across the region on the promotion of underutilized fruit trees; Participation of various groups of stakeholders.
Further information	Prof. E. Bellini Dept. of Ortoflorofrutticoltura University of Florence, Via Donizetti 6, 50144 Florence, Italy. http://www.maich/medusa

Working Group on Underutilized Fruit Crops

Lifespan	Began in 1994
Support	CIHEAM
Organisation	Coordinated by the Instituto Valenciano de Investigaciones Agrarias (IVIA), Moncada (Valencia), Spain.
Objectives	Understand present status and develop future prospects for five underutilized fruit species; Try to identify major problems in their cultivation and commercialisation and address them through joint initiatives.
Focus	Fig, loquat, Japanese persimmon, pomegranate and barbary fig.
Participation	12 Mediterranean countries.
Work carried out	Gathering information and sharing experiences across the Mediterranean on the selected species through a number of workshops.
Experiences	Enhance cooperation across the region on the promotion of underutilized fruit crops.
Further information	http://www.iamz.ciheam.org/

Mediterranean Selected Fruits Inter-Country Network (MESFIN)

Lifespan	Began in 1993.
Support	Food and Agriculture Organization of the United Nations and voluntary contributions from participating countries.
Organisation	Coordinated by the University of Cukurova, Adana, Turkey.
Objectives	Broad coverage of issues from germplasm collection to use, transfer of technology and public awareness.
Focus	A long list of fruits from the Mediterranean and sub-tropical region, including various minor fruit tree species.
Participation	Mediterranean countries.
Work carried out	Overview of country/regional situations and establishment of a global network (REMUFRUT) under whose broader framework MESFIN would fall, setting up of initial germplasm database.

Experiences	Cooperation across the region enhanced; Campaigning for greater support by policy makers.
Further information	Prof. Önder Tuzcu University of Cukurova, Adana, Turkey Email: otuzcu@mail.cu.edu.tr

EUCARPIA's Working Group on underutilized crops

Lifespan	Initiative launched in 1998.
Support	European Association for Research in Plant Breeding (EUCARPIA).
Organisation	Group on underutilized crops established within the section on plant genetic resources coordinated by Institute für Pfanzengenetik und Kulturpflanzenforschung (IPK) of Gatersleben, Germany (Prof. Karl Hammer) and the Germplasm Institute, Italy (Prof. P. Perrino) during the EUCARPIA Conference on Genetics and Breeding, held in Viterbo, Italy in September 1998.
Objectives	Promotion of underutilized species in Europe; Raise awareness among breeders on minor crops; Strengthen cooperation between breeders and conservation workers.
Focus	Yet to be decided.
Participation	All members of EUCARPIA.
Work carried out	None as yet. The implementation of activities to be discussed at the National Symposium of the Germplasm Institute of Bari (Italy) planned for May 2000.
Further information	Dr Pietro Perrino Istituto del Germoplasma, National Research Council Via Amendola 165A, 70126, Bari, Italy Email: germpp04@areaba.cnr.it

European Fruit Research Institute Network (EUFRIN)

Lifespan	Began in 1993.
Support	All costs associated with attending EUFRIN meetings or conducting its activities are paid for by its participating members.
Organisation	Organisation of Research Institutes and University Departments that specialise in research, development and extension on temperate fruit crops and which are based within the countries of the European Union and Switzerland.
Objectives	▪ Enhance and facilitate coordinated research, development and technology transfer, focused on aiding sustainable production of quality fruit; ▪ Establish and improve cooperation between those involved in fruit research and development within Europe; ▪ Create a philosophy of fruit production through research. EUFRIN embraces research and development on all temperate tree and small (soft) fruit species. This includes apples, pears, quinces, cherries, plums (prunes), apricots, peaches, nectarines, strawberries, raspberries, blackcurrants, red currants, gooseberries and other similar crops grown in the regions of Europe experiencing temperate climatic conditions.
Focus	Fruit (annual or perennial) species, including minor fruit crops.

Participation	14 European countries; working groups.
Work carried out	Development of project proposals to submit to donor agencies.
Experiences	Bringing together various research organisations across the region.
Further information	http://www.eufrin.org

Patrimonie Genétique, biodiversité et savoir populaires de la Région Provence Alpes Côte d'Azur (PAGE PROVENCE)

Lifespan	Began in 1983.
Support	Partly self supporting, partly supported by the Regional Committee and departmental committees of the Region Provence Alpes Côte d'Azur (French territorial collectivities).
Organisation	Coordination in France.
Objectives	Promotion of information exchange of indigenous knowledge and germplasm; Promotion of greater attention to local crop varieties. A number of "agrobiodiversity markets" for the Mediterranean region have been organised to highlight local varieties, including minor crops.
Focus	Plants and animals.
Participation	Open to any interested member (individual or organisation).
Work carried out	3 Mediterranean meetings, local fruit fairs, public awareness.
Experiences	Bringing together farmers and researchers to share experiences and work more closely for the sustainable maintenance of agrobiodiversity.
Further info.	M. Barriere, 39, rue du Refuge, 13200, Arles, France.

Henry Doubleday Research Association

Lifespan	Established in 1954.
Support	Through donations.
Organisation	Charity organisation based in the UK.
Objectives	Conservation of local varieties, organic farming and gardening.
Focus	Organic farming and display gardens also using minor crops.
Participation	Open membership.
Work carried out	Training, public awareness.
Experiences	Working with the informal sector and the public at large.
Further information	Henry Doubleday Research Association, Ryton Organic Gardens, Coventry, CV8 3LG, UK. http://www.hdra.org.uk

Alternative Crops Technology Interaction Network (ACTIN)

Lifespan	Launched in 1997.
Support	Through participating members.
Organisation	Network of private groups/companies.
Objectives	Enhance use of alternative crops/technologies through greater interaction among industries and researchers.
Focus	General, alternative food or non food crops, technologies.

Participation	Through membership fees.
Work carried out	Setting up a database on genetic resources for enhancing their uses through shared technological efforts.
Experiences	Working with wide representation of research in this domain.
Further information	http://www.actin.co.uk

National initiatives

Activities on minor crops are recorded in many national programmes across Europe. However, due to the low level of financial support provided to scientists for working on these species, these activities are generally carried out with *ad hoc* funds provided through special national/regional projects whose lifespan is generally limited to 3 to 5 years. An example is EU Regulation 1467/94, which has supported a number of projects on minor crops (such as *Beta* spp., *Brassica* spp., etc.), involving research institutes across the region. The personal enthusiasm of many scientists of national programmes in Europe, has led to interesting results, albeit scarcely publicised, on minor crops. These results have been achieved thanks to the personal dedication of investigators who have been working on these species while working on those major crops falling under their official responsibility. The recent growing attention being paid to minor crops is having a very good impact on this "grey" research and is also providing greater recognition for the many "silent" efforts over the years. An example to highlight is the two volumes entitled "Seeds from the past" produced in 1992 and 1999, resulting from the successful collaboration between the German Academy of Science and the National Research Council (CNR) of Italy. These volumes list all local crop germplasm in Italy, with emphasis on minor crops, providing their status of use and genetic erosion. This work was made possible thanks to the work of plant explorers and collectors of the Germplasm Institute of Bari and the Institute für Pfanzengenetik und Kulturpflanzenforschung (IPK) of Gatersleben, who patiently and passionately gathered unique data on minor crops for more than 20 years.

Many more useful documents in local languages on less known agrobiodiversity work have been published in Europe. The following is a list of some selected Italian books on the local use of wild, underutilized and neglected plant species in Italy published since 1872.

Arietti, N. 1941 La nostra flora nella economia domestica, Società Editrice La Scuola, Brescia.
(Our flora in the domestic economy).

Betto, G. 1983 Erbe mangerecce. A caccia di insalate, in: Giardino Fiorito, vol. 49/50.
(Edible herbs. Hunting for salads).

Bianco, V.V. 1989 Specie Erbacee della flora infestante pugliese utilizzabili come ortaggi e piante da condimento, in: Atti e relazioni dell'Accademia pugliese delle Scienze, 46 tomo II, Fasano, Grafischena.
(Weeds of the Apulia Flora that can be used as vegetables and for condiment).

Bianco, V.V. 1990 Piante spontanee della flora italiana utilizzate come ortaggi, in: Orticoltura, a cura di V.V. Bianco e F. Pimpini, Bologna, Patron.
(Spontaneous plants of the Italian Flora used as vegetables in horticulture).

Castelvetro, G.	1974	Breve racconto di tutte le radici, di tutte l'erbe e di tutti i frutti, che crudi o cotti in Italia si mangiano, in: Gastronomia del Rinascimento, a cura di L. Firpo, Torino, UTET. (A short account of all the roots, herbs and fruits, raw or cooked, used in Italian gastronomy during the Renaissance period).
Ciampi, C.	1961	Piante officinali di uso domestico, Firenze. (Condiment, aromatic and medicinal plants of domestic use in Italy).
Corsi, G. and A.M. Pagni	1979	Piante selvatiche di uso alimentare in Toscana, Pacini Editore, Pisa. (The wild plants of Tuscany and their gastronomic use).
Corsi, G. and A.M. Pagni	1979	Le piante spontanee nell'alimentazione popolare, in: Atti della Società Toscana di Scienze Naturali Mem. Serie B, 86. (Spontaneous plants used in popular cooking).
Di Tonno, N. and Lamusta S.	1997	Sapori e aromi da piante e frutti spontanei della Puglia peninsulare, Edizioni Amici della "A. De Leo", Brindisi. (Tastes and flavours of spontaneous herbs and fruits of the peninsular Apulia region).
Frattola, I.	1940	Piante medicinali italiane e loro uso popolare, A Signorelli, Roma. (Medicinal plants and their popular use).
Frazer, J.	1981	Frutti selvatici. Dove e quando raccoglierli, come utilizzarli, Fabbri, Milano. (Wild fruits. Where and when to harvest and use them).
Lanzani Abbà, A.	1988	Il bosco in cucina, Mondadori, Milano. (Food of the forests).
La Sorsa, S.	1941	Alberi, piante e erbe medicinali nella tradizione popolare italiana, Ist. Graf. Tiberino, Roma. (Trees, herbs and medicinal plants in Italian popular tradition).
Lieutaghi, P.	1977	Il libro delle erbe. Le loro proprietà medicinali, il loro uso culinario, dove trovarle, come coltivarle e raccoglierle, Rizzoli, Milano. (The book of herbs, their medicinal properties, their culinary use, where to find and how to harvest them).
Lodi, G.	1957	Piante officinali italiane, Edagricole, Bologna. (Condiment, aromatic and medicinal plants of Italy).
Longo, A.	1931	Primo contributo alla conoscenza scientifica dei termini dialettali, usati nel leccese per indicare le piante indigene spontanee e coltivate ed i prodotti più usati derivati da piante esotiche, Tip. Cuppini, Bologna. (First contribution to the scientific knowledge of dialectal terms used in the Leccese dialect to refer to local spontaneous and cultivated species [...]).
Malfatti, A.	1991	La cucina del prato, Muzzio, Padova, Spinardi (eds.). (Meadow cookery).
Riccardo, S.	1921	Le piante spontanee èduli della nostra flora, Battiato, Catania. (Spontaneus edible plants of our Flora).

Righi Parenti, G. 1893 Tesori e profumi dell'orto. Quarantasei piante da riscoprire per gustare i sapori di un tempo, per esser sani e belli in modo naturale..., Sugar Co, Milano.
(Treasures and smells of the orchard. 46 plants to rediscover forgotten flavours [..]).

Tenore, V. and G.A. Pasquale 1872 Atlante di Botanica popolare, ossia illustrazione di piante notevoli di ogni famiglia, R. Petraroja R., Napoli.
(Atlas of popular Botany).

Not all of these publications adopt a scientific approach. However, they contribute to defining the level of use of and interest in these species among the local people, who ultimately are the major players in their sustainable conservation.

The 1994 UMS project to survey expertise on underutilized species across the Mediterranean region also represented a valuable source of information for locating expertise and interest on minor crops across national programmes in southern Europe.

With regard to the role of local European NGOs most active in safeguarding minor crops and promoting their use, the following groups should be mentioned: The Irish Seed Savers Association (Ireland), Page Provence (France), Archeologia Arborea (a small association which has been gathering and conserving forgotten local varieties of fruit trees in central Italy), Pomona (very active in raising public awareness in Italy on forgotten varieties of minor fruits), Pro Specie Rara (Switzerland) and Vidaverde, Spain (an NGO from Andalucia dedicated specifically to the collection and promotion of underutilized food crops). An analysis of European NGOs and their contribution to conserving agrobiodiversity is available in Proceedings of Braunschweig (Mulvany 1999). A detailed survey of European NGOs holding germplasm collections was prepared in 1998 by the Henry Doubleday Research Association, through support provided by IPGRI's Regional Office for Europe.

Global activities

IPGRI

IPGRI's activities on neglected and underutilized species (NUS) involve more than 15 projects implemented in partnership with national programmes from countries all over the world. As a whole, more than 50 species are being addressed in these efforts, covering a wide range of crops, from fruit trees to root and tuber crops, to multipurpose tree species. Activities are carried out in close cooperation with international organisations such as the Consultative Group on International Agricultural Research (CGIAR) sister centers, the Food and Agriculture Organization of the United Nations (FAO) and the International Center for Underutilized Crops (ICUC). Closer collaboration with the Global Forum for Agricultural Research (GFAR) is being sought to strengthen international support in this strategic area of research.

IPGRI's activities on NUS can be grouped into five main domains:

- **Participatory research**
  Neglected and underutilized species constitute a category defined by their social value and status. For this reason people and farmers play an important role in reversing their decline in use and arresting their genetic erosion. Activities at IPGRI cover anthropological and ethnobotanic research aspects aimed at enhancing the human capacity for the successful promotion of these species. Special attention is paid to the community knowledge based on use, nutrition programmes and strengthening links among primary stakeholders.
- **Complementary conservation approaches**
  Given the close relationship between use and the maintenance of genetic diversity of neglected and underutilized species, special attention is needed to maintain

complementarity between *ex situ* and *in situ* conservation efforts. Activities in this domain range from the development of community-based systems, such as home gardens, to the establishment of core collections for facilitating maintenance and effective use of those accessions maintained in *ex situ* genebanks.

- **Documentation, information dissemination and enhancement of capacities**
  Documentation and information play a crucial role in the enhancement of the use of neglected and underutilized species. Since its establishment in 1974, IPGRI has produced more than 80 publications dealing specifically with these species. Particularly significant are those crop monographs (24 so far), developed through a special project financed by Germany, which cover both scientific issues (such as taxonomy, biology, crop improvement and conservation needs), as well as knowledge on use and marketing of a number of representative species. Lists of scientists working on neglected and underutilized species are also produced through the monograph series. All IPGRI publications dealing with this subject can be downloaded from the Internet (http://www.cgiar.org/ipgri/publicat).
- **Fostering synergism at national, regional and international level**
  IPGRI commonly employs networking as a way to deliver its main objectives. This *modus operandi* has proved successful with major crops programmes and also with neglected and underutilized species. A project focusing on underutilized Mediterranean species was successfully carried out from 1994 to 1998 thanks to the support of the Italian Government. This work and other similar networking initiatives coordinated by IPGRI have contributed to raising the attention of scientists on neglected and underutilized species and promoting greater synergism in research domains largely left uncovered by national programmes.
- **Legal and policy frameworks and public awareness**
  Legal and policy frameworks are often a major constraint to the enhancement of uses of underutilized and neglected species. IPGRI is very active in global fora to raise awareness on neglected and underutilized species and the development of systems for the fair share of benefits arising from their use. IPGRI's contribution to promoting these species at the international level includes inputs in the development of the FAO's Global Plan of Action for PGRFA, proposals for an underutilized species alternative list to be included in the FAO's International Undertaking on PGR and support to an international workshop addressing the role of underutilized species in food security.

Consultative Group on International Agricultural Research (CGIAR)

Several of the CGIAR centers are engaged in research on minor crops. However, as in most cases, these species do not fall within the official mandate of the centers. Therefore, the research is supported by a very limited budget and relies mainly on *ad hoc* donor support. Examples include: the work of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, on bambara groundnut; the work of the International Potato Centre (CIP) in Lima, Peru, on Andean tuber crops; and the work of the International Center for Agricultural Research in the Dry Areas (ICARDA) in Aleppo, Syria, on the establishment of an Arboretum for underutilized fruit and forest species in the CWANA region (work began in late 1999 in collaboration with IPGRI's Regional Office for CWANA). A further stimulus for greater CGIAR participation in activities dealing with underutilized and neglected crops resulted from the Workshop organised by the CGIAR and the M. S. Swaminathan Research Foundation at Chennai, India, in February 1999. The Chennai meeting acknowledged the ongoing work of several CGIAR Centers. It recognised, however, that despite the evident demand, research and development activities on neglected species have been sporadic and lacking in a coherent framework and strategy. Thus the meeting called for greater attention to be focused on

this area of research and recommended the establishment of a global platform to address such work at the international level.

Global Forum on Agricultural Research (GFAR)

IPGRI received a request from the GFAR Secretariat for the development of a Concept Note on underutilized species to serve as a background for discussion at the General GFAR Meeting planned to take place in Dresden, Germany, in May 2000. The document, already developed and circulated among stakeholders for comments, analyses the needs in this area at the global level and addresses the role played by all the actors (from the growers up to the ultimate users) and whose strengthening would ultimately boost the promotion of these crops. The European Component of the GFAR has indicated a keen interest in supporting activities on underutilized species for contributing to food security and income generation, and thus the possibility of linking this initiative to the ECP/GR Working Group on Minor Crops should be explored.

International Center for Underutilized Crops (ICUC)

ICUC is an autonomous, non-profit, scientific research and training center. It was established in 1988 and is currently based at the University of Southampton, UK. The Center was established to address ways of increasing the use of underutilized crops both for food, medicinal and industrial products and also for environmental improvement. The following text taken from the ICUC's web page (http://www.icuc.org) describes the activities of ICUC pursued by this organization:

- **Research and development:**
  Underutilized crops have a major role to play in the development of alternative cropping systems, crop diversification, development of value-added products and provision of products for industrial and medicinal use. They also have a role to play in the sustainable use of the environment and the restoration of degraded lands. ICUC establishes priorities among species and encourages research on those of highest priority. Accordingly, several research projects on identified high priority species have been undertaken by the staff of ICUC in partnership with National Agricultural Research Systems and other international centers (e.g. tropical fruits in Asia and Africa, indigenous vegetables in Africa and industrial crops in Asia). Improvement of farm economies through the use of underutilized crops management programmes (e.g. crop diversification, agroforestry, homestead farms, peri-urban and urban land use development).
- **Networking**
  Establishment of regional and global networks. ICUC is essentially a networking operation that undertakes a coordinating and catalytic role. To meet the objectives ICUC has established a regional network on underutilized fruits in Asia (UTFANET) with the cooperation of the Commonwealth Science Council, the Asia-Pacific Association of Agricultural Research Institutions and FAO. A regional network on underutilized crops in southern and eastern Africa (SEANUC) has also been established.
- **Information systems**
  ICUC is building up its database on underutilized crops. This database contains information collected from many sources, much of it generated from ICUC's activities on commodity crops: fruits and nuts; pulses, vegetables, roots and tubers; oilseed and industrial crops; and forage, fodder and energy species. The information includes botanical, agricultural and product data on many underutilized plant species that is not easily accessible elsewhere.
- **Training courses**
  ICUC runs courses in Southampton and abroad in partnership with universities and organisations. These courses include assessment of diversity, propagation and

production methods of tropical fruits, use of germplasm and *in vitro* and molecular techniques for improvement of underutilized crops. The syllabus of these courses has been designed in full recognition of the need to provide training in the rapid improvement of underutilized plant species.

- **Publications**
  ICUC publishes series of monographs of underutilized crops and also the proceedings of meetings held at different regions to promote underutilized crops for food, nutrition, industry and sustainable development. ICUC also produces a regular Newsletter.

In 1999 IPGRI and ICUC initiated a joint research study aimed at assessing the status of conservation and use of underutilized species around the world. The survey is expected to be completed in mid 2000.

International Atomic Energy Agency (FAO/IAEA)

A specific project addressing the promotion of underutilized species for low income deficit countries (LIDC) around the world, was launched by FAO/IAEA in 1998. The project, which focuses on a number of key priority crops (yams, bambara groundnut, okra, amaranth, etc.), covers aspects related to the use enhancement of underutilized crops, including the application of irradiation techniques in facilitating their crop improvement. IPGRI is a partner in this initiative and provides technical backstopping to national programmes in the project. Among other things, this support includes the provision of advice on methodologies to better conserve and enhance use of available collections, characterize and document genetic diversity of selected crops, assist in the development of descriptor lists, etc.

Center for New Crops and Plant Products, Purdue, USA

This Center is gaining popularity in the area of the promotion of "new" crops. The term "new" (referred in most cases to new introductions to the USA) often includes many species that are underutilized and neglected at various levels. The Center is the driving force of periodical conferences, held every 3 years, dedicated specifically to new crops. These conferences, so far held in the USA (the last was held in Phoenix, AR in 1998), represent one of the largest gatherings of experts around the world on themes related to the introduction, cultivation and marketing of new crops. Although the initial focus was on the USA, the conferences have become very popular outside the country and are considered important fora for exchanging research findings, new ideas and updates on the state of use of minor crops from all over the world. The text of the proceedings of conferences that have been produced so far is available free of charge on the Center's Internet site (http://www.hort.pudue.edu/newcrop). The Purdue web site is also a valuable source of information for experts on minor crops from around the world.

Prospects

Among the priority areas that have been recommended for moving the European minor crop agenda forward are those developed at the Braunschweig Meeting and those agreed upon at the 1998 EUCARPIA Meeting in Viterbo, Italy. According to the author, the following are the most urgent issues to be brought to the attention of ECP/GR:

Braunschweig (June 1998)

- identification of the minor crops basket;
- identification of threats of genetic erosion;
- priority setting;
- assessment of expertise in the region;
- inventory of existing activities;
- establishment of links with existing activities/networks.

EUCARPIA (September 1998)

- assessment of degree of use of minor crops;
- identification of potentials and promotion related constraints;
- database on experts among EUCARPIA.

Taking these points into account, what should be ECP/GR's role in their implementation?

ECP/GR's major assets are its ability to catalyse research on plant genetic resources across Europe and canvass support for the implementation of research that countries have agreed upon. The successful model of ECP/GR, deployed over almost 20 years, has achieved a more secure conservation and sustainable use of major commodities in the region. This model can also be applied to minor crops in the hope that a similar success will follow.

Among the areas of work where ECP/GR can promote synergism through the newly established Minor Crops Network are the items in the table below that can be brought to the attention of the ECP/GR Steering Committee for its endorsement:

Organization	Crops	Themes
IPGRI	Rocket, oregano and hulled wheat to be continued; Fruit trees in Central Asia, collaboration with Central Asia and Caucasus Plant Genetic Resources.	Networking; Training; Technology transfer.
CIHEAM	MEDUSA Database (MAICh); Underutilized Fruit Trees (CIHEAM).	Training; Documentation of plant genetic resources and other research topics.
GFAR-CGIAR	Link the work with the Agricultural Research Institutes of the European Union Contact group initiative on promotion of non-mandates Consultative Group crops.	Various topics including biotechnology and documentation of plant genetic resources.
ICUC	Various species, some of which are of potential interest also for Europe.	Commercialisation and marketing.
FAO	Various species.	Training component in the context of the IAEA project and MESFIN Network.
Purdue	Various species.	Compilation of a database of experts on minor crops for Europe

Final remarks

Launching a new initiative on minor crops inevitably poses a number of challenges particularly in the area of priority setting. Which species will be picked from the large basket of minor crops? From the long list of identified needs, which ones should be tackled and how will we ensure that our actions are the most useful and cost effective?

For a more thorough coverage of this topic, readers should refer to the book Priority Setting Methodology, developed by IPGRI through a fully participatory Conference held in Aleppo, Syria in 1998 (Padulosi 1999b). To the suggestions that the reader will find in this book, the author would like to stress:

- the need to establish effective links with relevant existing activities on minor crops;
- the need to identify areas of comparative advantages across stakeholders before deciding on assignment of tasks for implementing an agreed agenda;
- the need to properly assess areas of weaknesses for minor crops where contributions are most needed (e.g. the commercialisation, marketing etc.);
- the need to use focus (selection of few species to use as models) in order to do not dilute limited resources;
- the need to disseminate outputs to the beneficiary groups (which include farmers and users at large);
- the need to continue lobbying for more consistent support for minor crops.

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Conservation of genetic resources of medicinal and aromatic plants in Europe

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Introduction

Herbal medicines represent an important economic factor in the European Union (EU). Sales figures in Europe are estimated at US$7 billion per year (Benzi and Ceci 1997; Lange 1998). This is a result of the use of about 2 000 herbal medicines. Germany holds the biggest share (US$2.5 billion), followed by France (US$1.6 billion) and Italy (US$0.6 billion). An average annual expenditure on herbal remedies per EU citizen is estimated at US$17.4 (Benzi and Ceci 1997).

Herbal medicines are used all over the world in preventive medicine and represent a way of lowering healthcare costs in many developed countries.

The use of herbal preparations over millennia in the history of mankind, growing awareness of the role of medicinal plants in drug development and the modern "back to nature" trend, have increased global attention on medicinal and aromatic plants (MAP) research. Consequently, the vast and expanding market of medicinal plants has been putting pressure on natural resources as most species used in herbal preparations are still collected in the wild. According to Traffic International (1998), 90% of European MAP which are used commercially are collected in the wild. Analysis of trade data shows that Europe imports about a quarter of the annual global market imports (440 000 t with an estimated value of US$1.3 billion in 1996). Germany, France, Italy, Spain and the UK are the leading importers, whereas Germany, Bulgaria and Poland lead in export. Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania and Turkey are the countries that export more MAP than they import.

There are numerous players with an interest in MAP conservation:

- The pharmaceutical industry initiated the idea of chemical prospecting of new active compounds with potential use in phytotherapy, cosmetics and the food industry. Quality assurance became an essential component of competition in drug markets. Regulations on medicinal plant products have been ratified by the European Community (OJ-EC/2444/18.7.1989). These regulations stress that consistent quality for products of vegetable origin can only be assured if the basic materials are defined in a strict and detailed manner.
- Agricultural institutions have shown that the genetic diversity of wild populations can be used to select useful traits and to obtain standardised bred material.
- "Conventional" or allopathic medicine has shown an interest in the evaluation and scientific recognition of traditional medicines. The World Health Organization suggests that alternative and traditional systems should be scientifically evaluated. Technical guidelines and international standards should be developed. Legal aspects of herbal medicine usage in different countries depend largely on the ethnological, medical and historical background of each respective country.
- Market demand for over-the-counter herbal remedies is increasing. An annual global growth of 12-15% is estimated. The TRAFFIC Network is planning a series of medicinal plant projects to assess the impact of trade on both wild plant populations and local healthcare systems.

Leading health organizations, agricultural institutions and pharmaceutical industries have been introducing national programmes for the inventory of medicinal plants and for the evaluation of natural resources (through the collection of wild accessions, *in situ* and *ex situ* cultivation in botanical gardens and in commercial plantations / agrosystems). Standardisation of raw material has become an important issue with respect to medicinal products in the European Union.

In situ *conservation*

Excessive utilisation of wild MAP from natural habitats and environmental degradation due to human activities are the main reasons why MAP are often considered endangered in many European regions. Many countries have launched systematic programmes of *in situ* conservation of MAP. In Lithuania, for example, a programme investigating about 100 spontaneous MAP species, divided into groups according to the level of endangeredness, began in 1981 (Radusiene *et al.* 1996). *In situ* conservation is often one of the strategies used by genebanks, such as the Nordic Gene Bank or in Italy, where MAP are maintained *in situ* through national parks, biosphere reserves or on farms (Perrino and Begemann 1994).

Slovenian botanists have maintained an inventory of Slovenian flora (not exclusively MAP) throughout the last decade. The inventory is aimed at securing a basis for conservation of the remaining natural resources of rare and / or endangered species. The result of this intensive research is "The Red Data List of Threatened Vascular Plants in Slovenia" (Wraber and Skoberne 1989) which is endorsed by the Institute for the Conservation of Natural and Cultural Heritage of Slovenia. This document is based on The World Conservation Union (IUCN) categories and is a result of the classification of endangered plants according to the degree of danger. Amongst approximately 3 000 plant species known to be autochthonous or well adapted to the Slovenian climate, some 10% are estimated to be endangered (34 are endangered, 77 vulnerable, 192 are rare). Slovenia has been committed to the preservation of natural resources such as medicinal plants (there are over 100 autochthonous species with possible medicinal properties).

In Slovenia, directives for the national programme of production, processing and quality control of MAP have been set. The strategy for preservation of natural resources is perceived to be of utmost importance. The programme has been supported by the Slovenian Ministry for Agriculture, Forestry and Food and by the Ministry for Health (Baričevič 1996). The first stage of the programme on production, processing and quality control consists of the monitoring of natural populations, their characterisation and *in situ* conservation of evaluated autochthonous plant material. To obtain data on wild accessions of MAP in Slovenia, information from the Ljubljana Herbarium and floristic / vegetation inventories and documents are used. The method proposed is based on phytogeographic regions.

Conservation of the natural heritage for future generations, followed by the importance of an attractive landscape, are among the principles calling for a strategy for the conservation of MAP. The main elements of this strategy are the following:

- Establishment of inventories of natural resources and estimates of the level of endangeredness in nature;
- Active conservation (conservation *in situ* and *ex situ*);
- Sustainable use of natural resources (limitation of massive exploitation of natural resources can be achieved through the cultivation of known genotypes in suitable environments).

In Slovenia, *in situ* inventories or monitoring and estimation of population density, as well as quality control with the objective of defining particular or optimal market

use of raw materials, are planned to be carried out with the use of the multiuser relational database MEDPLANT. Wild populations are going to be included in the National Collection of Medicinal and Aromatic Plants. Further activities related to MAP cultivation (such as propagation of plant materials and seed production) are planned.

Ex situ *conservation*

Development of appropriate genebank technologies is needed to ensure optimal maintenance of germplasm and its homogeneity (seed maturity, storage conditions, propagation methods). For example, Hungarian researchers focused attention on the influence of seed maturity and storage periods on seed germination of *Foeniculum vulgare, Carum carvi, Datura stramonium, Cnicus benedictus and Borago officinalis* (Toth *et al.* 1996). Special efforts were made at the IPK Genebank in Gatersleben, Germany, where propagation methods, pollination patterns and characters of accessions have been studied on many of the MAP maintained there (*Coriandrum, Ocimum, Mentha, Datura, Petroselinum, Hyoscyamus, Anethum, Plantago, Carthamus, Chrysanthemum, Melissa, Digitalis, Calendula, Foeniculum, Rheum, Carum, Nigella, Origanum, Ruta, Salvia, Satureja, Artemisia*) (Diederichsen and Pank 1996; Gladis *et al.* 1996).

In 1996 the Slovenian Fund for Nature Conservation ratified the Resolution on Conservation of Biological Diversity and Permanent Landscape Development, which also includes MAP. In order to safeguard genepools for future investigations, a National Genebank Collection of Medicinal and Aromatic Plants containing 650 autochthonous or foreign/introduced MAP accessions was set up in 1994. It was formally recognised in 1995 and has been supported annually by the Slovenian government. This *ex situ* genebank has the following objectives:

- Maintenance of germplasm (seed, *in vitro* and *in vivo* collections), seed propagation (for cultivation purposes) and micropropagation of *Cynara scolymus, Salvia officinalis, Gentiana lutea, Origanum vulgare, Mentha piperita, Melissa officinalis, Hyssopus officinalis, Thymus vulgaris, Satureja montana*. Screening of optimal *in vitro* conditions (in terms of rapid propagation, morphological uniformity and low cost) is of special importance. The genebank accessions are used for micropropagation experiments where sterilisation of plant material, optimal choice of culture media and rooting capacity are tested. After four years of experience, the micropropagation of MAP has been accepted as an essential tool in order to obtain homogenous descendants in cross-pollinated species, in species with low rates of germination and with dormant seeds, as well as in virus infected plant material.
- Evaluation of morphological and chemotaxonomic characteristics of MAP (*Origanum vulgare, Origanum hirtum*).
- Evaluation of MAP ecotypes for quantitative and qualitative differences in secondary metabolites influencing growth and development.
- Evaluation of susceptibility of germplasm descendants to environmental stress (drought, low temperature, depleted soils, etc.) in pot trials in controlled environments (*Atropa belladonna, Origanum hirtum, Satureja montana, Thymus vulgaris,Trigonella foenum-graecum*).

Evaluation and Documentation

A unidimensional database is not adequate for the efficient analysis of parameters on different levels. In order to manage the extensive data and information flow that derives from the above studies, our Working Group recently developed a relational database which we called MEDPLANT (Baričevič *et al.* 1994: Baričevič *et al.* 1996). MEDPLANT was set up in order to collect and organise floristic, faunistic, taxonomic and analytic data on MAP of Central European and Mediterranean regions.

Future Plan of Action - Cultivation

In Europe, MAP are cultivated on some 70 000 ha, mainly in France, Hungary and Spain. Italy has also successfully increased cultivation of MAP (*Lavandula officinalis, Lavandula hybrida, Iris germanica, Salvia officinalis, Gentiana lutea*) (Laghetti *et al.* 1993). Sustainable use of MAP in Europe can be achieved by promoting the cultivation of "wild" plants. One of the essential tasks in the near future is the preparation of an official list of MAP descriptors. This will represent a basic document for the selection of useful traits and prebreeding of wild material. Breeding for uniformity of chemical characteristics is not only requested by the food and pharmaceutical industries, but is also the basis for the development of sustainable agrosystems including the cultivation of MAP.

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Genetic Resources of Minor Fruit and Nut Trees in Europe

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Introduction

Europe has long been a site of temperate and, to some extent in the Mediterranean belt, subtropical fruit and nut tree production. A wide range of native and foreign tree species have been cultivated here since early times and many others have been introduced more recently. Apart from major fruit crops such as apples, peaches, grapes, olives, citrus and almonds, minor fruits like figs, pomegranates, persimmons, loquats, pistachios, stone pines, carob pods and cactus pear, have received little attention regarding both conservation and use. According to Heywood and Zohary (1995), and based on *Flora Europaea*, the inventory of wild relatives of cultivated plants native to Europe is very rich regarding fruit and nut crops such as apple (*Malus*), pear (*Pyrus*), plums and cherries (*Prunus*), grape vine (*Vitis*), olive (*Olea*), fig (*Ficus*), raspberries and blackberries (*Rubus*) and stone pine (*Pinus*).

European countries are also a rich source of germplasm of several underutilized tree crops. The Mediterranean area is particularly rich in genetic resources of minor crops and should be considered as a priority area for conservation and collection. The European continent has both active commerce and consumption of some of them. Only a few years ago, now forgotten minor fruits were used locally for a variety of purposes. However, currently, some of them are neglected and facing genetic erosion. The genetic diversity of crops, represented by traditional local cultivars and wild relatives has been disappearing rapidly in recent decades. Initial concern was raised in the 1930s and by the 1960s, modern intensive orchards, plant breeding, propagation methods, commercial policies and land use changes accelerated its loss. Thus the setting of a priority list for the conservation of minor tree fruit and nut species is much needed in Europe.

In recent years, due to increasing public awareness of the importance of conserving plant genetic resources, combined with the traditional healthy Mediterranean diet, a number of major and minor fruit and nut tree species have been the focus of renewed interest not only in Europe but also worldwide. Olive oil and carob bean gum are only two examples, one major and the other minor, of the economic importance of two Mediterranean crops which are currently largely used by the food industry (Tous and Ferguson 1996; Batlle and Tous 1997). In Spain, there is an interesting local case with the blackthorn industry development in the Navarra region. Some 150 ha of *Prunus spinosa* were recently planted to produce homogeneous and quality fruits for the liquor industry of "Pacharán" (Benito and Subia 1998). In the USA the effective "five-a-day" campaign to encourage people to eat at least five vegetables or fruits every day is only a modern imitation of the traditional and well balanced Mediterranean diet. In addition, apart from economical considerations, there are other related issues to the NUS (neglected and underutilized species) like agriculture diversification, sustainability, use of marginal lands, land desertification, agroforestry, climatic changes and food security which are very important.

The objective of this short paper is to focus on the scarcity of information available about genetic resources of minor fruits in Europe. I propose that an open list of minor fruit and nut species grown in Europe be considered. I also suggest that some activities on genetic resources of these crops be raised, discussed, agreed and eventually supported. In addition, the need to cooperate with other related networks, groups and projects in order to coordinate efforts and avoid duplication of tasks, must be stressed.

List of Species

A non-exhaustive list of fruit and nut species growing in Europe which could be regarded as minor is provided (Table 1). The list contains 27 species considered more or less neglected by researchers or which have been underused economically. There is variability in the main uses for which they are suitable, their economic importance, market availability and conservation status. This preliminary list of minor fruit species should be revised in the light of some criteria already developed for other initiatives. A questionnaire on minor fruit and nut trees could be distributed to some experts. A few species from this list are already the focus of other active Research Networks, such as cactus pear, fig, loquat, persimmon, pistachio, pomegranate and stone pine. The newly established ECP/GR Network on Minor Crops could start focussing on only two tree species, such as one of wide distribution in Europe like arbutus (*Arbutus unedo* L.), and the other of southern distribution like carob (*Ceratonia siliqua* L.).

Table 1.- Open list of minor fruit and nut tree species growing in Europe

Common name	Species	Family	Main use	Cultivars or ecotypes	Genebank
Annona	*Annona cherimola* Mill.	Annonaceae	Fruit	√	√
Arbutus	*Arbutus unedo* L.	Ericaceae	Fruit	√	-
Azarole	*Crataegus azarolus* L.	Rosaceae	Fruit	√	-
Bay	*Laurus nobilis* L.	Lauraceae	Condiment	-	-
Bilberry	*Vaccinium myrtillus* L.	Ericaceae	Fruit	-	-
Blackthorn	*Prunus spinosa* L.	Rosaceae	Fruit	√	√
Buckthorn	*Hippophae rhamnoides* L.	Elaeagnaceae	Orna. & fruit	-	-
Black mulberry	*Morus nigra* L.	Moraceae	Orna. & fruit	√	-
Cactus pear	*Opuntia maxima* (L). Miller	Cactaceae	Fruit	√	√
Carob	*Ceratonia siliqua* L.	Leguminosae	Fruit & seed	√	√
Cornelian cherry	*Cornus mas* L.	Cornaceae	Fruit	√	-
Date palm	*Phoenix dactylifera* L.	Palmae	Fruit	√	√
Feijoa	*Feijoa sellowiana* Berg.	Mirtaceae	Fruit	√	-
Fig	*Ficus carica* L.	Moraceae	Fruit	√	√
Jujube	*Ziziphus lotus* (L). Lam.	Ramnaceae	Fruit	√	-
Juniper	*Juniperus communis* L.	Cupressaceae	Fruit	-	-
Loquat	*Eriobotrya japonica* (Thunb.)	Rosaceae	Fruit	√	√
Medlar	*Mespilus germanica* L.	Rosaceae	Fruit	√	-
Mountain ash	*Sorbus acuparia* L.	Rosaceae	Ornamental	-	-
Persimmon	*Diospyrus kaki* L.	Ebenaceae	Fruit	√	√
Pistachio	*Pistacia vera* L.	Anacardiaceae	Fruit	√	√
Pomegranate	*Punica granatum* L.	Punicaceae	Fruit	√	√
Quince	*Cydonia oblonga* Miller	Rosaceae	Fruit	√	√
Rowan	*Sorbus domestica* L.	Rosaceae	Orna. & fruit	-	-
Sumach	*Rhus coriaria* L.	Anacardiaceae	Fruit	-	-
Stone pine	*Pinus pinea* L.	Pinaceae	Forest & nut	√	√
White mulberry	*Morus alba* L.	Moraceae	Orna. & leaf	√	-

√ : existing

- : inexistant or unknown

Activities

The limited information available on many aspects of minor crops hinders their development and sustainable conservation. Information available on most of the species' germplasm is scattered and not readily accessible. Also, existing knowledge on the potential value of germplasm accessions of underutilized crops is limited. Both *ex situ* and particularly *in situ* conservation should be considered for neglected species. In recent years, several countries of southern Europe have begun surveys of native material

in collections and of the genepools of five of these crops: barbary fig or cactus pear, fig, Japanese persimmons, loquat and pomegranate (Llácer *et al.* 1995).

Activities such as collecting information in each country on research centres, institutions, experts, field of research, genebanks, germplasm documentation and publications related to the species selected, should be undertaken in order to make them available in inventories or catalogues (printed and on CD rom). Also, descriptors of some species could be developed. In a few cases, collecting missions should also be supported.

Coordination

The establishment of the ECP/GR Minor Crops Network supported by IPGRI, according to the recommendations made at the Nitra Conference held in 1995, should be a positive step towards the conservation of the genetic resources of this wide group of crops.

Priority setting and coordination of the activities with other already established and related research networks, groups or projects would be essential for the effectiveness of the task ahead. This would also avoid wasteful duplication of efforts. Such groups or projects could include: the IPGRI Project on Underutilized Mediterranean Species (UMS); the Cooperative Working Group on Underutilized Fruit Crops in the Mediterranean Region of the Centre International de Hautes Etudes Agronomiques Méditerranéennes (CIHEAM-MAIZ); the Mediterranean Selected Fruit Intercountry Network (MESFIN) under the aegis of FAO; the CIHEAM-MAICh MEDUSA Network of the Mediterranean Region funded also by the EU; the FAO-CIHEAM Interregional Cooperative Research Network on Nuts; and the FAO supported International Cooperation Network on Cactus pear (CACTUSNET).

The UMS project focused on a number of selected species indigenous to the Mediterranean region. The Cooperative Working Group on Underutilized Fruit Crops in the Mediterranean Region comprises five species – fig, loquat, persimmon, pomegranate and barbary fig. The MESFIN Network, for which a list of contact persons is given below, includes 17 families or species – Annonaceae, avocado, date palm, fig, guava, loquat, mango, persimmon, pomegranate, longam, carambola, litchi, papaya, pineapple, passion fruit and feijoa. The FAO-CIHEAM Inter-regional Cooperative Research Network on Nuts focusses on seven species – almond, hazelnut, walnut, pistachio, pecan, chestnut and stone pine. Also worth considering are the results of the three year project entitled “Genetic resources of neglected crops with good development potential: their conservation, use and breeding status” undertaken jointly by IPGRI and the Institute for Plant Genetics and Crop Plant Research (IPK), Germany. An interesting series of 25 monographs entitled “Promoting the conservation and use of underutilized species” on worldwide species including three minor fruit tree species (carob, tamarind and *Passiflora* sp.) have been produced by IPGRI.

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Minor Crops in the Mediterranean Region

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Introduction

Cyprus is the third largest island in the Mediterranean region, with an area of 9 251 km^2. The climate is an intense Mediterranean one, with wet, changeable winter weather from November to March and hot, dry summers, from May to September, separated by short spring and autumn seasons of rapidly changing weather. Out of a total government controlled area of 575 000 ha, only 140 000 ha are considered to be suitable for agricultural use. The rest, which accounts for 76% of the total area, consists of arid, uncultivated and forest land and developed areas. In general, the predominant crops in rainfed lands are cereals, fodder crops, grapevines and olive trees. Of the irrigated crops, the most important are citrus, vegetables and fruit trees (Della 1996). The most significant export commodities are potatoes and citrus. The major export market for agricultural products is the European Union.

Indigenous plant genetic resources

The vegetation of Cyprus is formed by typical Mediterranean types; the coniferous forest, the maquis, the garigue and the batha vegetation, (Meikle 1977; 1985; Della 1987; 1995a) while more localized communities occur around salt marshes, sand dunes, stone walls and mountain streams.

A total of 1 906 taxa (sp. + ssp. + var. + f. + hybrids) were recorded in Cyprus as native or naturalized and 376 taxa as cultivated. Of the native taxa 142 were recorded as endemics (Della 1999).

Amongst Cyprus's natural vegetation, a number of aromatic, medicinal and other useful plants are being exploited in their wild form i.e. *Origanum* spp. (*Origanum dubium* Boiss.) the "Rigani" or "Riganis" of the Cypriots has long been valued as the source of a valuable aromatic oil. It is harvested, dried, packed and sold as an aromatic substance for food. Likewise sage, *Salvia fruticosa* Mill., the "Spatzia" of the Cypriots, is collected from the wild and is used as a medicinal plant in the preparation of herbal teas against sore throats and colds. *Thymus capitatus* (L.) Hoffsgg. et Link "Throumbi", or "Thymari" is collected and is used as an aromatic herb in cooking. The tender shoots, the buds and the fruit of the wild caper, ("Cappari") *Capparis spinosa* L. var. *canescens* Cosson, as well as the tender leaves of *Eryngium maritimum* L. ("Mangallos") are consumed, preserved in vinegar as appetizers. The tender leaves or shoots of *Silene* spp. (“Strouthouthkia”), *Asparagus* spp. (“Agrelia”), *Malva* spp. (“Molocha”) and of other species are gathered from the wild and are used for making omelettes or eaten boiled with olive oil and lemon juice.

Rosa damascena Mill., the Damask Rose (triantafilia myrodhati), a very ancient garden rose, is cultivated in villages at high elevations as an aromatic plant. Flowers are used to prepare rosewater and also to make sweets in heavy syrup.

Aromatic and medicinal plants are grown at the Athalassa (near Nicosia) Government Nursery (Department of Agriculture) for evaluation and utilization. A number of the above species are already grown on a commercial scale. Research work at the Agricultural Research Institute includes studies of plant population density, cutting height, selection of different genotypes of oregano (Droushiotis and Hadjichristodoulou 1998), experiments with pre and post emergence herbicides in a number of aromatic plant species (Vouzounis 1998) and irrigation experiments to

study the effect of irrigation on the yield and quality of oregano, sage and lavender (Metochis 1998).

Among the wild shrubs which are partly used for their aromatic fruits are: Lentisk, *Pistacia lentiscus* L. ("Schinia", "Schinnos") and *Pistacia terebinthus* L. (Terebinth, "Trimithkia"). The aromatic fruit of *Pistacia atlantica* Desf. ("Tremithos") the mastic producing tree, which is used for making pies, was used in the past for oil production. *Laurus nobilis* L. (laurel) is gathered or grown for its aromatic leaves and fruit. The leaves are used as aromatics and the oil from its fruit in cosmetology.

An interesting plant of economic importance is *Rhus coriaria* L. (Sumach, "Roudhi" "Soumatji") an erect or spreading shrub to about 2 m in height, which grows on stony mountainsides and in vineyards from 600-1800 m. The leaves of *Rhus coriaria,* which is an industrial plant rich in tannin, are collected every year and exported.

Crataegus azarolus L. (azarole, "Mosphilia"), a small round headed tree, is grown on rocky mountainsides, by road sides or by field margins, where it is often planted. It is found from sea level to 1200 m altitude. Its fruit is gathered and is eaten fresh or used to make homemade jams. It is used also in industry.

The carob tree, *Ceratonia siliqua* L., the "Charoupia" or "Teratsia" of the Cypriots, which is grown in the wild, is also cultivated for its ripe fruit. It grows on dry hillsides in garigue and in coastal and sub-maritime maquis from sea level to 700 m. It is widely cultivated in lowland areas.

The carob tree is an inseparable element of the natural and cultural heritage of Cyprus. It is a dryland crop, friendly to the environment. Carobs had long been harvested as a major crop called the "black gold" of Cyprus. During the 1960s the low prices of the International market and the increase in labour costs gradually resulted in abandoning the crop. From the data of 1977 and 1994 inventories it seems that the total number of trees decreased to 77%. According to the 1994 inventory, the total number of trees is estimated to be 265,764 (Kenonis 1997). As a result, the total crop production was gradually decreasing and in 1997 was 5,100 tons with a percentage value over the total plant production of only 0.37 %. (Anonymous 1997).

Wild progenitors of ornamental species such as *Tulipa* spp., *Narcissus* spp., *Anemone* spp., *Cyclamen* spp., *Orchis* spp. , *Ophrys* spp. , *Fritillaria* spp. etc. exist among the wild vegetation of Cyprus. Unfortunately, their numbers are rapidly decreasing due to continuous developmental activities, herbicides and inconsiderate exploitation.

The seed of a number of Cyprus trees and shrubs, such as *Nerium oleander* L. (Oleander, "Arodhaphni"), *Myrtus communis* L. (Myrtle, "Mersinia"), *Laurus nobilis* L. (Bay laurel, "Daphni") is gathered by the Forestry Department and plants are provided free of charge to be grown in Municipal, Governmental, private and school gardens as ornamentals. Plants of the Cyprus flora, promoted by the Ministry of Agriculture, Natural Resources and the Environment to be utilized as ornamentals, were presented by Della in 1996 in Naples, Italy, in the Consultation Meeting of Neglected Plant Genetic Resources with a Landscape and Cultural Importance for the Mediterranean Region (Della 1997a).

Landraces and old cultivars

Local varieties of artichoke (*Cynara scolymus* L.), bottle gourd, the "Nerokoloko", "Krasokoloko", Calabach gourd the "Kreatokoloko" (*Lagenaria siceraria* (Mol.) Standley), loofach (*Luffa cylindrica* (L.) M. J. Roem.), sweet pepper (*Capsicum annuum* L.) are still grown in Cyprus. The Ministry of Agriculture, Natural Resources and the Environment, encourages their use by seed multiplication and selling at cost price (Della 1996).

Introduced, high yielding uniform cereal varieties were released during recent years, replacing local germplasm almost completely. Relicts of the old durum wheat

varieties might only be found in semi-mountain vine areas of Paphos, where the improved varieties are not competitive and mechanization cannot be practised. Local varieties of Barley have disappeared from farmers' fields (Della 1997b).

Local varieties of pulses are still the main varieties grown. However, improved chickpea, cowpea and common bean varieties, as well as selected local faba beans, were recommended for cultivation by the Agricultural Research Institute and were released. The area under cultivation is decreasing rapidly, exposing local germplasm to the danger of genetic erosion or even extinction. Cultivation of lentil, chickpea and ochrus vetch is minimal. The main reasons for this are the shortage and high cost of labour and the lower prices of imported pulses.

As regards forage legumes, the cultivation of bitter vetch (*Vicia ervilia* (L.) Willd.) and of chickling vetch (*Lathyrus sativus* L.) is also minimal and local germplasm has almost disappeared. *Vicia sativa* L. is still grown on a large scale. However, detrimental to the local germplasm was the drought during 1991, which destroyed the crop and resulted in the import of seed of a foreign variety, for sowing in the 1991/92 growing season (Della 1997b).

Local varieties of loquats, citrus, hazelnuts, figs, pomegranate, walnuts, apricots and plums are still grown in Cyprus. There is a tremendous variation in local almond germplasm. Research work is being carried out on loquat, citrus, hazelnuts and figs. Selected germplasm of fruit trees is multiplied and supplied to the farmers.

Plant breeding in Cyprus is conducted at the Agricultural Research Institute. The aim of this work is to produce varieties, suitable for the dry and hot climate of Cyprus. Crosses are made between local varieties and improved varieties of cereals and faba beans. For other field crops of small economic importance, varieties developed in other countries or International Centers are introduced and evaluated in Cyprus.

National Conservation Activities

In Situ Conservation Measures

The State Forests are managed and protected by the Forestry Department in accordance with the existing Forest Law. Important ecosystems, which were declared as National Forest Parks or Nature Reserves, as well as very old trees are protected by law. Plants within the State Forests are also reasonably protected. However, no direct measures have been taken as yet for the conservation of wild relatives of crops in their natural habitat. There are no measures for on farm conservation of local varieties of crops either.

Cyprus has ratified the Washington Convention on the International Trade in Endangered Species of Wild Fauna and Flora, the Bern Convention on the Conservation of the European Wildlife and Natural Habitats as well as the Convention concerning the Protection of the World Cultural and Natural Heritage.

Nineteen taxa, eighteen of which are endemics, proposed in the Convention of Bern in 1979 (reviewed in Strasburg during 1992) are also protected by law.

Cyprus signed the Rio Convention on Biological Diversity in 1992 and ratified the Convention in 1996.

Legislation for the protection of Nature was recently prepared by the Cyprus Government in accordance with European Union relevant regulations and directives. It includes *inter alia* legislation for the protection of the National Genebank (CYPARI) and of the National Herbarium.

Ex Situ Collections - National Genebank

The National Genebank which contains local material, was established in 1985. The active collection consists of approximately 12,000 samples mainly cereals, food and

forage legumes (Della 1995b; Della 1997b). Material is kept in heat-sealable foil pouches at 0-4 °C.

The awareness of the genetic resources programme to give priority to the conservation of the remaining genetic variability of cereals, grain and forage legumes is highly justified. Most of the crop germplasm that has been collected and stored in the genebank has disappeared from farmers? fields (Della 1997 b).

The conservation and use of old varieties of artichoke, water bottle, loufach, sweet pepper is encouraged by the Ministry of Agriculture, Natural Resources and Environment by multiplying the seed and selling to the farmers at cost prices (Della 1996).

Since 1997 the Government of Cyprus has supported the conservation and harvesting of carob trees by subsidizing the product which is delivered to the cooperatives (Anonymous 1997).

There are field genebanks of olives, citrus, loquats, figs, pomegranates, hazelnuts, walnuts. The collections are at stations belonging to the Ministry of Agriculture, Natural Resources and Environment, either at the ARI or the Department of Agriculture. Almonds were collected in 1996 (Della and Gregoriou 1997). Preliminary studies were also conducted in 1997 in an effort to suggest the need for on farm conservation of the local variety Kaisha (*Prunus armeniaca* L.).

There is no Botanical garden in Cyprus as yet. However, there are some botanical collections at the Forestry Department and the Department of Agriculture.

A number of indigenous trees and shrubs, as well as other species of the Cyprus flora, are produced every year at the Nursery of the Forestry Department and provided free of charge for planting in schools, Government and Municipal Gardens, in Archaeological places, -along highways, by walk ways etc. A number of them are sold at very low prices to the public (Della 1997a).

In an effort to increase public awareness and interest for the protection, conservation and sustainable utilization of the indigenous flora, promotion is carried out through all mass media including radio and television. Promotional lectures, with the view to boosting the enthusiasm among students of all ages, are given by the Ministry of Agriculture, Natural Resources and Environment in cooperation with the Ministry of Education and Civilization. During field days, with the active participation of students, teachers and the public, numerous plants are planted in school gardens and other public areas.

Table 1 presents the neglected and underutilized species of Cyprus. Table 2 presents the area, production, value of production and its contribution to the total value of plant production, for a number of minor crops whilst Table 3 presents the data for vegetable crops and melons.

Table 1. Neglected and Underutilized species of Cyprus

Scientific name	Common name	Local name	Fruit species, nuts	Vegetable Species	Forage Species	Aromatic Species	Medicinal species	Industrial Crops
Ceratonia siliqua L.	carob tree	Charoupia or Teratsia			*			*
Rhus coriaria L.	sumach	Roudhi, Soumatzi						*
Pistacia atlantica Desf.	mastic tree	Tremithos				*		*
Pistacia lentiscus L.	lentisk	Schinia or Schinnos				*		
Pistacia terebinthus L.	terebinth	Trimithkia				*		
Crataegus azarolus L.	azarole	Mosphilia	*					*
Cytonia oblonga Mill.	quince	Kydonia	*					*
Origanum dubium Boiss.	origan	Rigani				*		
Salvia fruticosa Mill.	sage	Spatzia					*	
Thymus capitatus (L.) Hoffsgg. et Link	thyme	Throumbi or Thymari				*		
Rosa damascena Mill.	rose	Triantafilia myrodhati				*		
Capparis spinosa L. var. *canescens* Cosson	caper	Cappari						*
Prunus armeniaca L.	apricot & kaisha	Kaisha	*					*
Ficus carica L.	fig tree	Sykia	*					*
Laurus nobilis L.	bay laurel	Daphni				*		
Cynara scolymus L.	artichoke	Agginara, Tzinara		*				
Asparagus officinalis L.	asparagus	Sparaggia, Agrelia		*				
Colocasia esculenta (L.) Schott	taro	Colocasi		(tuber)				
Phoenix dactylifera L.	date-palm	Phinikia	*					
Lagenaria siceraria (Mol.) Standley	bottle gourd	Nerokoloko, krasokoloko		*				
	calabach gourd	kreatokoloko						
Luffa cylindrica (L.) M.J. Roem.	loofach	Eliphi		*				
Amygdalus communis L.	almond tree	Amygdalia, athashia	*					
Punica granatum L.	pomegranate	Rothkia, Rovkia	*					
Juglans regia L.	walnut tree	Karythkia	*					
Corylus avellana L.	hazel-nut tree	Fintoukia	*					
Prunus domestica L.	plums	Damascena	*					
		Pournelia						
		Marapelia						
Eriobotrya japonica Thunb. Lindley	loquat	Mespilia	*					

Table 2. Area, production and value of a number of minor crops (including improved varieties)

Crop	Area (ha)	Production (tons)	Value of Production £ 1000's	Value of Plant Production (% of the total)
Carob	2500	5100	566,1	0.37
Pistachio	220	32	88,0	0.06
Quinces	13	80	30,6	0.02
Apricot + Kaisha	250	1700	1072,7	0.70
Figs	330	3800	1987,4	1.30
Artichokes	160	2500	910,0	0.60
Almonds	3100	1360	911,2	0.60
Colocasi	95	2200	1654,4	1.09
Oats	270	280	70,0	0.05
Broadbeans fresh + dry	435	1350	678,1	0.44
Cowpeas fresh + dry	320	2110	1,286,5	0.84
Chickpeas	90	160	84,8	0.05
Lentils	5	3		
Louvana	40	50	24,0	0.02
Forage crops (vicos, vetches, favetta)	78	73	29,4	0.02
Pomegranates	170	700	260,4	0.17
Walnuts	400	210	735,0	0.48
Hazelnuts	100	50	37,5	0.02
Tobacco	70	322	428,3	0.28
Sesame	3	1	1,2	
Groundnuts	320	1350	1417,5	0.93
Plums	175	1100	907,5	0.59
Loquats	60	300	220,2	0.14

Source: Department of Statistics and Research (1997)

Table 3. Area, production and value of number of vegetable crops and melons (including improved varieties).

Crop	Area (ha)	Production (tons)	Value of Production £ /1000s	Value of plant Production (% of the total)

Vegetables				
Potatoes	7.000	81.500	16.633,3	10.94
Food potatoes	6.925	80.030	16.326,1	10.73
Seed potatoes	75	1.470	307,2	0.20
Carrots	55	2.000	520,0	0.34
Tomatoes	345	34.000	8.806,0	5.79
Colocase	95	2.200	1.654,4	1.09
Cucumber	180	13.500	3.969,0	2.61
Haricot beans fresh	485	2.400	1.509,6	0.99
Haricot beans dry		400	520,0	0.34
Cabbages	150	4.900	1.004,5	0.66
Onions	190	6.800	1.190,0	0.78
Onion sets	8	80	80,0	0.05
Onions Fresh (1000 bundles)	60	2.000	218,0	0.14
Artichokes	160	2.500	910,0	0.60
Cauliflower	90	2.200	649,0	0.43
Marrows	158	3.900	1.310,4	0.86
Egg-plants	63	3.200	972,8	0.64
Beetroots	75	2.650	516,7	0.34
Celery (1000 bundles)	50	2.500	480,0	0.32
Okhra	73	1.300	744,9	0.49
Pepper	63	1.600	779,2	0.51
Peas fresh	82	1.200	507,6	0.33
Mushrooms	-	2.170	2.923,0	1.92
Other (leafy veg.etc)	605	-	3.170,0	2.08
Melons	925	-	6.421,5	4.22
Water melons	700	34.500	4.450,5	2.93
Sweetcorn	225	9.000	1.971,0	1.30

Source: Department of Statistics and Research (1997)

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Crops of European origin

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Introduction

Europe is not usually considered a cradle of agriculture and horticulture, but it has a wealth of plant genetic resources (Hammer & Schlosser 1995). Whereas the major crops have been introduced from the Southeast, minor crops have been developed and domesticated in the area. There are only a few estimates available on the number of crop plants in Europe. Hammer (1999) estimated 500 crop plants on the basis of 7000 crop plants worldwide and other data. However, there is no inventory enumerating the relevant species.

Materials and methods

Schlosser *et al.* (1991) compiled the useful plants list from the list of wild plants of middle Europe (Ehrendorfer 1973). Using Schlosser *et al.* (1991) as a reference, information about the cultivated species was obtained. Nine groups of use have been considered as indicated in Table 1. The species have been classified according to their main use. Ornamental plants, ornamental and lawn grasses (O); woody plants for wind breaks, soil erosion control or ornament (W); and forest trees (F) have not been considered in the groups of main use.

The cultivation for one of the nine groups of use, regardless of time and location of cultivation, was taken as the principal criterion for the inclusion of a species in the list of European crops. Many species were cultivated in the past and some European plants became crops in other parts of the world. Additional information was obtained from the "Mansfeld Dictionary" (Schultze - Motel 1986), a compiled list of worldwide cultivated plants. Introduced species have not been included in the present inventory.

Results

Most of the species selected belong to the minor crops. None belongs to the list of 30 main world crops. In all, 350 crop species have been found together with their primary use (see Annex to this paper).

Medicinal and spice plants resulted as the richest use groups with 138 species (Table 1), followed by fodder plants (86 species) and vegetables (54 species). Grain legumes, starch and sugar crops and technical crops include only a few species each.

Table 1. Number of species of crop plants from middle Europe in various use groups

Group	Number of species
Medicinal and spice plants ***(MS)***	138
Fodder plants ***(Fo)***	86
Vegetables and related ***(V)***	54
Fruit trees, including nuts and grafting stocks ***(Fr)***	32
Oil crops ***(Oi)***	16
Technical crops, special uses ***(T)***	9
Starch and sugar crops ***(St)***	8
Plants for recultivation, soil stabilization and improvement ***(R)***	4
Grain legumes ***(GL)***	3
	350

The crop plants from middle Europe come from 61 plant families (Table 2). The families with the highest number of species are: Gramineae (52 species); Leguminosae (46 species); and Rosaceae (35 species). Only one species is cultivated in each of 29 the families.

Table 2. Number of species in the plant families of minor crop plants in middle Europe

Family	Number of species
Gramineae	52
Leguminosae	46
Rosaceae	35
Compositae	28
Labiatae	27
Cruciferae	21
Umbelliferae	18
Chenopodiaceae	10
Liliaceae	9
Polygonaceae	8
Caryophyllaceae	7
Ranunculaceae, Scrophulariaceae	5
Boraginaceae, Crassulaceae, Salicaceae, Solanaceae	4
Papaveraceae, Juncaceae, Scrophulariaceae, Grossulariaceae	3
Ericaceae, Gentianaceae, Geraniaceae, Malvaceae, Valerianaceae, Caprifoliaceae, Corylaceae, Euphorbiaceae, Rubiaceae, Plantaginaceae, Primulaceae	2
Alismataceae, Amaranthaceae, Hypericaceae, Linaceae, Urticaceae, Anacardiaceae, Berberidaceae, Cucurbitaceae, Campanulaceae, Cornaceae, Dipsacaceae, Elaeagnaceae, Cannabaceae, Iridaceae, Vitaceae, Juglandaceae, Onagraceae, Violaceae, Lauraceae, Menyanthaceae, Oxalidaceae, Verbenaceae, Paeoniaceae, Polemoniaceae, Portulacaceae, Resedaceae, Rutaceae	1

Discussion

List of crop species

A list of minor crop plants from the central part of Europe is now available (see the Annex to this paper). Other parts of Europe should participate in efforts to compile a list of the remaining European minor crop plants. An example can be drawn from Italy. Since 1980 exploration work in the field, supported by data from literature, has been carried out to compile a list of all cultivated plants (excluding ornamentals and forest trees). Southern Italy and Sicily have been included in the first catalogue (Hammer *et al.* 1992) comprising 524 species. In central and northern Italy 551 crop species have been found (Hammer *et al.* 1999). Together with the data from middle Europe, these results could form a nucleus for further work in Europe. The coordination of the necessary forthcoming activities could be carried out by the authors of this paper.

The check-list method has been proposed for the field studies (Hammer 1991). So far, there is no indication that our efforts have been followed on a country basis in other parts of Europe. Studies in Albania were recently initiated (see Hammer and Spahillari 1998).

Coverage in European collections

With a few exceptions (e.g. the Gatersleben genebank in Germany, for medicinal and aromatic plants with nearly 3 000 accessions, Hammer 1993), there are no larger collections of minor European crop plants in the genebanks of Europe. Landraces and local selections are usually not available and obviously have already disappeared in many cases. But for many of the European crops, the wild relatives still occur and can be

protected in nature reserves and other areas (Schlosser, 1984) thus providing new stimulus for *in situ* conservation.

Priority needs for future collecting

The first priority is the collection of the remaining previously mentioned landraces and local selections. Information about them is difficult to obtain. Inventories should be compiled for minor crops in countries or geographic areas. On this basis, red books for endangered crop plants can be developed (Hammer 1998), while currently they are only available for wild plants.

The Mediterranean area is especially rich in minor crop species (Padulosi 1997). Consequently, this area should be primarily included in future collecting missions. In the more northern areas, genetic erosion is usually high, so that a kind of rescue mission has to be proposed.

With regard to wild relatives, an effective cooperative approach with nature protection has to be developed.

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Annex to the paper by K. Hammer and M. Spahillari

Crops of middle european origin (for abbreviations see Table 1)

Achillea collina	(Compositae)	MS
Achillea millefolium	(Compositae)	MS O Fo
Achillea ptarmica	(Compositae)	O MS
Achillea tomentosa	(Compositae)	MS O
Aconitum napellus	(Ranunculaceae)	MS O
Adonis aestivalis	(Ranunculaceae)	O MS
Adonis vernalis	(Ranunculaceae)	MS O
Aegopodium podagraria	(Umbelliferae)	V MS
Agrimonia eupatoria	(Rosaceae)	MS
Agropyron caninum	(Gramineae)	Fo
Agropyron intermedium	(Gramineae)	Fo St R
Agropyron junceum	(Graminaea)	R St
Agropyron repens	(Gramineae)	MS St Fo R
Agrostemma githago	(Caryophyllaceae)	O St
Agrostis canina	(Gramineae)	O Fo
Agrostis capillaris	(Gramineae)	O Fo
Agrostis castellana	(Gramineae)	O Fo
Agrostis gigantea	(Gramineae)	Fo R
Agrostis stolonifera	(Gramineae)	O R Fo
Ajuga reptans	(Labiatae)	O MS
Allium schoenoprasum	(Liliaceae)	V MS
Allium scorodoprasum	(Liliaceae)	V MS
Allium ursinum	(Liliaceae)	MS V
Allium victorialis	(Liliaceae)	V
Allium senescens subsp. Motanum	(Liliaceae)	V
Alopecurus arundinaceus	(Gramineae)	Fo
Alopecurus pratensis	(Gramineae)	Fo O
Althaea officinalis	(Malvaceae)	MS
Amaranthus lividus	(Amaranthaceae)	V
Amelanchier ovalis	(Rosaceae)	Fr W
Ammophila arenaria	(Gramineae)	R
Amygdalus nana	(Rosaceae)	W Fr
Anchusa azurea	(Boraginaceae)	O MS
Anchusa officinalis	(Boraginaceae)	MS V
Angelica archangelica	(Umbelliferae)	MS V
Anthemis tinctoria	(Compositae)	O MS T
Anthericum ramosum	(Liliaceae)	O MS
Anthoxanthum odoratum	(Gramineae)	Fo O
Anthyllis vulneraria	(Leguminosae)	R MS Fo
Apium graveolens	(Umbelliferae)	V MS
Aquilegia vulgaris	(Ranunculaceae)	O MS
Arctium lappa	(Compositae)	MS V
Arctostaphylos uva-ursi	(Ericaceae)	MS Fr W
Armeniaca brigantiaca	(Rosaceae)	MS
Armoracia rusticana	(Cruciferae)	MS
Arnica montana	(Compositae)	MS
Arrhenatherum elatius	(Gramineae)	Fo O
Artemisia absinthium	(Compositae)	MS O
Artemisia pontica	(Compositae)	MS
Artemisia vulgaris	(Compositae)	MS V R
Asparagus officinalis	(Liliaceae)	V MS
Astragalus cicer	(Leguminosae)	Fo R
Astragalus glycyphyllos	(Leguminosae)	Fo MS
Atriplex nitens	(Chenopodiaceae)	V Fo
Atriplex rosea	(Chenopodiaceae)	Fo
Atropa bella-donna	(Solanaceae)	MS
Barbarea vulgaris	(Cruciferae)	O V MS Fo O
Beckmannia erucaeformis	(Gramineae)	Fo
Bellis perennis	(Compositae)	MS O
Berberis vulgaris	(Berberidaceae)	St V Fo MS
Beta vulgaris	(Chenopodiaceae)	St V Fo MS
Betonica officinalis	(Labiatae)	MS
Brachypodium pinnatum	(Gramineae)	R O
Brassica nigra	(Cruciferae)	Oi MS Fo V

Brassica oleracea	(Cruciferae)	Oi V Fo O
Brassica rapa	(Cruciferae)	O V Fo
Briza media	(Gramineae)	O Fo
Bromus arvensis	(Gramineae)	Fo
Bromus erectus	(Gramineae)	Fo
Bromus hordeaceus	(Gramineae)	Fo
Bromus inermis	(Gramineae)	Fo R O
Bromus secalinus	(Gramineae)	Fo
Bromus tectorum	(Gramineae)	R
Bryonia dioica	(Cucurbitaceae)	MS O
Bunium bulbocastanum	(Umbelliferae)	V MS Fo
Bupleurum rotundifolium	(Umbelliferae)	MS
Calamagrostis epigejos	(Gramineae)	R O
Camelina alyssum	(Cruciferae)	Oi
Camelina sativa	(Cruciferae)	Oi
Campanula rapunculus	(Campanulaceae)	V
Capsella bursa-pastoris	(Cruciferae)	V MS
Carum carvi	(Umbelliferae)	MS
Centaurium erythraea	(Gentianaceae)	MS
Cerasus avium	(Rosaceae)	Fr W Fo
Cerasus fruticosa	(Rosaceae)	Fr W
Cerasus x *intermedia*	(Rosaceae)	MS
Cerasus mahaleb	(Rosaceae)	MS W MS T
Chaerophyllum bulbosum	(Umbelliferae)	V
Chelidonium majus	(Papaveraceae)	MS
Chenopodium album	(Chenopodiaceae)	V St Fo
Chenopodium bonus-henricus	(Chenopodiaceae)	V MS
Chenopodium foliosum	(Chenopodiaceae)	V
Chenopodium hybridum	(Chenopodiaceae)	V
Chenopodium murale	(Chenopodiaceae)	V
Chenopodium vulvaria	(Chenopodiaceae)	MS
Cichorium intybus	(Compositae)	V MS T
Cirsium oleraceum	(Compositae)	V
Cochlearia officinalis	(Cruciferae)	Oi V MS O
Colchicum autumnale	(Liliaceae)	MS O T
Conium maculatum	(Umbelliferae)	MS
Conringia orientalis	(Cruciferae)	Oi V
Convallaria majalis	(Liliaceae)	MS O
Cornus mas	(Cornaceae)	Fr W MS R T
Coronilla varia	(Leguminosae)	R Fo MS O
Coronopus squamatus	(Cruciferae)	V MS
Corylus avellana	(Corylaceae)	O Fr W T
Corylus maxima	(Corylaceae)	O Fr W T
Crambe maritima	(Cruciferae)	V Fo
Crambe tatarica	(Cruciferae)	V Fo
Crataegus laevigata	(Rosaceae)	Fr MS W T
Crataegus monogyna	(Rosaceae)	Fr MS W T
Cynodon dactylon	(Gramineae)	Fo MS R O
Dactylis glomerata	(Gramineae)	Fo O
Dactylis polygama	(Gramineae)	Fo
Datura stramonium	(Solanaceae)	MS
Daucus carota	(Umbelliferae)	V MS Fo
Delphinium elatum	(Ranunculaceae)	O MS
Descurainia sophia	(Cruciferae)	MS
Digitalis grandiflora	(Scrophulariaceae)	MS O
Digitalis lanata	(Scrophulariaceae)	MS
Digitalis purpurea	(Scrophulariaceae)	MS O
Digitaria sanguinalis	(Gramineae)	St Fo
Diplotaxis tenuifolia	(Cruciferae)	V MS
Dipsacus fullonum	(Dipsacaceae)	T
Echinochloa crus-galli	(Gramineae)	St Fo
Echinops sphaerocephalus	(Compositae)	O MS
Epilobium angustifolium	(Onagraceae)	MS V Fo T
Eryngium maritimum	(Umbellifereae)	O V MS
Eupatorium cannabinum	(Compositae)	MS
Euphorbia lathyris	(Euphorbiaceae)	Oi MS O
Festuca arundinacea	(Gramineae)	Fo O R
Festuca nigrescens	(Gramineae)	O Fo

Festuca ovina	(Gramineae)	R Fo O
Festuca pratensis	(Gramineae)	Fo O
Festuca rubra	(Gramineae)	Fo O R
Filipendula vulgaris	(Rosaceae)	MS St Fo O
Fragaria moschata	(Rosaceae)	Fr
Fragaria vesca	(Rosaceae)	Fr MS
Fragaria viridis	(Rosaceae)	Fr
Galega officinalis	(Leguminosae)	MS Fo O
Galeopsis segetum	(Labiatae)	MS
Galium odoratum	(Rubiaceae)	MS
Gentiana lutea	(Gentianaceae)	MS
Geranium macrorrhizum	(Geraniaceae)	MS O
Geranium sanguineum	(Geraniaceae)	O MS T
Geum urbanum	(Rosaceae)	MS V T
Glaucium flavum	(Papaveraceae)	MS
Glechoma hederacea	(Labiatae)	MS R
Glyceria fluitans	(Gramineae)	St Fo
Gypsophila paniculata	(Caryophyllaceae)	O T
Helichrysum arenarium	(Compositae)	MS
Herniaria glabra	(Caryophyllaceae)	MS
Herniaria hirsuta	(Caryophyllaceae)	MS
Hippophaë rhamnoides	(Elaeagnaceae)	Fr R W MS
Holcus lanatus	(Gramineae)	Fo
Humulus lupulus	(Cannabaceae)	MS V O
Hyoscyamus niger	(Solanaceae)	MS
Hypericum perforatum	(Hypericaceae)	MS
Hyssopus officinalis	(Labiatae)	MS O
Iris pallida	(Iridaceae)	O MS
Isatis tinctoria	(Cruciferae)	T O Fo
Juglans regia	(Juglandaceae)	Oi Fr MS T Fo
Juncus effusus	(Juncaceae)	T R O
Juncus gerardii	(Juncaceae)	Fo
Juncus maritimus	(Juncaceae)	MS W T
Lactuca quercina	(Compositae)	MS
Lactuca serriola	(Compositae)	V
Lactuca virosa	(Compositae)	MS
Laser trilobum	(Umbelliferae)	MS
Lathyrus hirsutus	(Leguminosae)	Fo R
Lathyrus pratensis	(Leguminosae)	Fo
Lathyrus sylvestris	(Leguminosae)	R Fo O
Laurus nobilis	(Lauraceae)	MS W O
Lavandula angustifolia	(Labiatae)	MS O T
Lens nigricans	(Leguminosae)	GL
Leonurus cardiaca	(Labiatae)	MS T
Lepidium latifolium	(Cruciferae)	V MS
Leymus arenarius	(Gramineae)	R St O
Linum bienne	(Linaceae)	O T
Lolium multiflorum	(Gramineae)	Fo
Lolium perenne	(Gramineae)	Fo O
Lolium rigidum	(Gramineae)	Fo
Lotus corniculatus	(Leguminosae)	Fo
Lotus tenuis	(Leguminosae)	Fo
Lotus uliginosus	(Leguminosae)	Fo
Lupinus angustifolius	(Leguminosae)	GL Fo
Malus dasyphylla	(Rosaceae)	Fr
Malus sylvestris	(Rosaceae)	Fr L
Malva sylvestris	(Malvaceae)	MS
Marrubium vulgare	(Labiatae)	MS
Matricaria chamomilla	(Compositae)	MS
Medicago falcata	(Leguminosae)	R Fo
Medicago lupulina	(Leguminosae)	Fo R
Medicago minima	(Leguminosae)	Fo
Medicago sativa	(Leguminosae)	R Fo
Melilotus alba	(Leguminosae)	R Fo
Melilotus officinalis	(Leguminosae)	MS Fo T
Mentha aquatica	(Labiatae)	MS
Mentha arvensis	(Labiatae)	MS
Mentha x *dalmatica*	(Labiatae)	MS

Mentha x *gentilis*	(Labiatae)	MS
Mentha longifolia	(Labiatae)	MS
Mentha x *maximilianea*	(Labiatae)	MS
Mentha x *muellerana*	(Labiatae)	MS
Mentha x *piperita*	(Labiatae)	MS
Mentha pulegium	(Labiatae)	MS T
Mentha spicata	(Labiatae)	MS
Mentha suaveolens	(Labiatae)	MS
Mentha x verticillata	(Labiatae)	MS
Mercurialis annua	(Euphorbiaceae)	V MS
Mespilus germanica	(Rosaceae)	Fr W
Meum athamanticum	(Umbelliferae)	MS V O
Myrrhis odorata	(Umbelliferae)	MS
Myrtus communis	(Myrtaceae)	MS O
Nasturtium officinale	(Cruciferae)	V MS
Nymphoides peltata	(Menyanthaceae)	O V
Onobrychis viciifolia	(Leguminosae)	Fo
Ononis campestris	(Leguminosae)	MS
Origanum vulgare	(Labiatae)	MS O
Oxalis acetosella	(Oxalidaceae)	V MS T
Padus avium	(Rosaceae)	Fr W MS T
Paeonia officinalis	(Paeoniaceae)	MS O
Papaver rhoeas	(Papaveraceae)	O MS
Pastinaca sativa	(Umbelliferae)	V MS Fo
Petasites hybridus	(Compositae)	MS
Peucedanum ostruthium	(Umbelliferae)	MS
Phalaris arundinacea	(Gramineae)	Fo R O
Phleum alpinum	(Gramineae)	Fo
Phleum phleoides	(Gramineae)	Fo O
Phleum pratense	(Gramineae)	Fo O
Pimpinella saxifraga	(Umbelliferae)	MS
Plantago lanceolata	(Plantaginaceae)	MS Fo
Plantago major	(Plantaginaceae)	MS
Poa angustifolia	(Gramineae)	O R Fo
Poa bulbosa	(Gramineae)	Fo
Poa compressa	(Gramineae)	R Fo
Poa nemoralis	(Gramineae)	O Fo
Poa palustris	(Gramineae)	Fo
Poa pratensis	(Gramineae)	Fo O R
Poa trivialis	(Gramineae)	O F
Polemonium caeruleum	(Polemoniaceae)	O MS
Polygonum aviculare	(Polygonaceae)	MS V
Polygonum hydropiper	(Polygonaceae)	MS
Portulaca oleracea	(Portulacaceae)	V MS
Primula veris	(Primulaceae)	MS O
Primula vulgaris	(Primulaceae)	O V
Prunus spinosa	(Rosaceae)	Fr R W MS
Pulmonaria officinalis	(Boraginaceae)	MS V
Pyrus nivalis	(Rosaceae)	Fr
Pyrus pyraster	(Rosaceae)	Fr L Fo
Pyrus spinosa	(Rosaceae)	Fr
Raphanus raphanistrum	(Cruciferae)	Oi V Fo
Reseda luteola	(Resedaceae)	T Oi
Rhus coriaria	(Anacardiaceae)	T
Ribes nigrum	(Grossulariaceae)	Fr MS
Ribes rubrum	(Grossulariaceae)	Fr MS L
Ribes uva-crispa	(Grossulariaceae)	Fr L
Rosa gallica	(Rosaceae)	Fr MS L
Rosa majalis	(Rosaceae)	Fr MS L
Rosa pendulina	(Rosaceae)	Fr MS L
Rosmarinus officinalis	(Labiatae)	MS O
Rubia tinctorum	(Rubiaceae)	T MS
Rubus caesius	(Rosaceae)	MS Fr
Rubus chamaemorus	(Rosaceae)	Fr
Rubus fruticosus	(Rosaceae)	MS Fr O
Rubus idaeus	(Rosaceae)	MS Fr
Rubus saxatilis	(Rosaceae)	Fr
Rumex rugosus	(Polygonaceae)	V

Rumex alpinus	(Polygonaceae)	V MS Fo
Rumex hydrolapathum	(Polygonaceae)	V MS
Rumex patientia	(Polygonaceae)	V MS
Rumex scutatus	(Polygonaceae)	V MS
Rumex thyrsiflorus	(Polygonaceae)	Fo
Ruta graveolens	(Rutaceae)	MS O
Sagittaria sagittifolia	(Alismataceae)	St Fo O
Salicornia stricta	(Chenopodiaceae)	R V
Salix alba	(Salicaceae)	MS R W Fo T
Salix purpurea	(Salicaceae)	MS R W T
Salix triandra	(Salicaceae)	MS T W
Salix viminalis	(Salicaceae)	MS R T
Salvia officinalis	(Labiatae)	MS
Sambucus ebulus	(Caprifoliaceae)	MS R T
Sambucus nigra	(Caprifoliaceae)	Fr MS V
Sanguisorba minor	(Rosaceae)	V MS R Fo
Sanguisorba officinalis	(Rosaceae)	MS
Saponaria officinalis	(Caryophyllaceae)	MS O T
Satureja montana	(Labiatae)	MS O
Scorzonera hispanica	(Compositae)	V MS T
Sedum album	(Crassulaceae)	O V MS
Sedum maximum	(Crassulaceae)	O V MS
Sedum reflexum	(Crassulaceae)	O V MS
Sedum rosea	(Crassulaceae)	MS O
Serratula tinctoria	(Compositae)	T
Silaum silaus	(Umbelliferae)	MS
Sinapis alba	(Cruciferae)	MS Fo O V R
Sinapis arvensis	(Cruciferae)	Oi MS
Smyrnium olusatrum	(Umbelliferae)	V MS Fo
Solanum nigrum	(Solanaceae)	V MS
Sonchus oleraceus	(Compositae)	V MS Fo
Sorbus aucuparia	(Rosaceae)	Fr R MS W Fo T
Sorbus domestica	(Rosaceae)	Fr L MS
Spergula arvensis	(Caryophyllaceae)	Fo
Stellaria media	(Caryophyllaceae)	V MS R
Symphytum officinale	(Boraginaceae)	Fo V MS
Tanacetum cinerariifolium	(Compositae)	T
Taraxacum officinale	(Compositae)	V MS Fo
Teucrium chamaedrys	(Labiatae)	MS O
Teucrium scorodium	(Labiatae)	MS
Thymus pulegioides	(Labiatae)	MS O
Trifolium alpestre	(Leguminosae)	Fo
Trifolium campestre	(Leguminosae)	Fo
Trifolium fragiferum	(Leguminosae)	Fo
Trifolium hybridum	(Leguminosae)	Fo
Trifolium incarnatum	(Leguminosae)	Fo
Trifolium medium	(Leguminosae)	Fo
Trifolium pannonicum	(Leguminosae)	Fo
Trifolium pratense	(Leguminosae)	Fo MS
Trifolium repens	(Leguminosae)	Fo MS R
Trifolium subterraneum	(Leguminosae)	Fo R
Trigonella caerulea	(Leguminosae)	MS
Trisetum flavescens	(Gramineae)	Fo
Tussilago farfara	(Compositae)	MS
Urtica dioica	(Urticaceae)	MS T V Fo
Vaccinium vitis-idaea	(Ericaceae)	MS Fr
Valeriana officinalis	(Valerianaceae)	MS
Valerianella locusta	(Vallerianaceae)	V
Verbascum densiflorum	(Scrophulariaceae)	MS O
Verbascum phlomoides	(Scrophulariaceae)	MS O
Verbascum thapsus	(Scrophulariaceae)	Fo
Vicia cracca	(Leguminosae)	Fo
Vicia dumetorum	(Leguminosae)	Fo
Vicia hirsuta	(Leguminosae)	Fo
Vicia lutea	(Leguminosae)	Fo
Vicia narbonensis	(Leguminosae)	GL Fo
Vicia pannonica	(Leguminosae)	Fo
Vicia sativa	(Leguminosae)	Fo GL

Vicia sepium	(Leguminosae)	Fo
Vicia tenuifolia	(Leguminosae)	Fo
Vicia tetrasperma	(Leguminosae)	Fo
Vicia villosa	(Leguminosae)	Fo
Vinca minor	(Apocynaceae)	MS O
Viola arvensis	(Violaceae)	MS
Vitis vinifera	(Vitaceae)	Fr W
Xanthium albinum	(Compositae)	O T

Additional abbreviations

O = Ornamental plants, ornamental and lawn grasses
W = Woody plants for wind breaks, soil erosion control or ornament
F = Forest trees

Classification of economically important plants

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Introduction

In any project or activity dealing with plant genetic resources there is a need for subdivision of the material according to the scope of the activity. The world's crop plants, or rather, the economically important plants, can be grouped in several different ways according to usage, breeding system or other features expressed by the plant.

The concept of "crop plants" is itself already a subclass of the total plant kingdom. In ordinary language this term has been used to mean cultivated plants from which a harvest is taken. Taken literally, this rather narrow definition would exclude ornamental plants that are cultivated for aesthetic value only and are not harvested. Nevertheless, many ornamental plants are economically very important.

The word "crop" does not usually include wild plants that are not cultivated but from which a harvest is taken. The number of economically important wild plants can be very large, but many are only important regionally. In other words, what is considered an economically important plant in one part of the world may be economically unimportant plant in other parts.

When dealing with preservation of plant genetic resources, two groups of wild plants may need special attention: the regionally rare and endangered plants and the (often underutilized) wild relatives of established crops.

This presentation considers both wild and cultivated plants. The term "economically important" is used here instead of the more vague "crop plant". Classification examples are based on database structures used at the Nordic Gene Bank.

Taxonomic classification

The taxonomic classification system is a hierarchical system. It is also an exclusive grouping system, i.e. a plant belonging to one taxonomic group cannot be part of another group on the same hierarchic level. Although taxonomy is essential as a scientific communications system, a community working with economically important plants cannot rely on it as the only means to classify them.

In fields such as plant breeding, agriculture or the food industry, taxonomic grouping often needs complementary classification methods. Groupings based on derived substances (oil plants, fibre plants) or types of usage (food, energy) are more descriptive in terms of the type of plant and its possible uses.

Classification according to regional economic value and trade

Tables 1 and 2 show a simple example of a non-exclusive regional grouping system based on a plant's occurrence, threat and trade value. Each region is represented by at least one table showing the present status.

Table 1. Regional data on taxa / scalar values

Taxon	origin	occurrence	threat	trade	cultivation	breeding
Taxon1	9	9	0	9	3	5
Taxon2	1		0	9	7	7

Table 2. Regional data on taxa / simplified to Boolean values

Taxon	origin	occurrence	threat	trade	cultivation	breeding
Taxon1	Y	Y	N	Y	Y	Y
Taxon2	N	N	N	Y	Y	Y

A region is a geographical area that has dimensions in space and time. Generally, regions may be included in other regions; they can be distinct or overlapping. A country, as a political entity is a special case of a region in that it is linked with a human administration responsible for the fate of the area. All countries on earth form a global map of (ideally undisputed) non-overlapping regions. A district or county is a region within a country. Communities and villages are still further steps inside a hierarchy of regions within countries. Geographical regions, like countries, are also non-overlapping. Distribution maps of plant taxa, on the other hand, are overlapping. The distribution maps of both wild and cultivated plants can be viewed as regions that change their size and shape over time.

For each region, the following set of descriptors can be used to classify each taxon and culton:

- **Origin** - type of origin of the taxon in the region (natural or introduced). In some regions it may be possible to reconstruct the floristic history and classify plants into *native*, *archeophytes*, and *neophytes* (of recent introduction, aliens). In regions where the cultural landscape is older this reconstruction is more difficult to make.
- **Occurrence** - a scalar value or range of classes that shows the abundance of the plant in natural environment.
- **Threat** - a scalar value or class range which is currently used internationally to rate the level of threat against the taxon, such as: in need of monitoring; rare; vulnerable; endangered; and extinct. (Reference: World Conservation Monitoring Center: IUNC Red List Categories; http://www.wcmc.org.uk).
- **Trade** - a scalar value or range of classes showing the amount of trade of products originating from the taxon. The trade value should also reflect the usage level in the region of the taxon, or products derived from it.
- **Cultivation** - a scalar value or range of classes showing the level of cultivation of the taxon within the region.
- **Breeding** - a scalar value or range of classes showing the level of breeding activity within the region.

Giving periodic values for each field can include the time element, i.e. providing three tables for each region, to show the past, present and future (estimated) values. The "future" table would reflect the expectations on the taxon in question. The "past" table should give a hint of the recent changes.

The smaller the regions, the more accurately value maps can be generated. It may be difficult to obtain information that is accurate enough to establish a range of values, so using tables with logical "present-absent" values instead may be a compromise that makes summaries for larger regions easier to compile when sub-regional data is incomplete.

Non-exclusive classification based on cultivation and usage characteristics

Classification according to type of cultivation/occurrence

Plants can be grouped according to the type of cultivation. The cultivation type may be looked upon as a loosely grouped range of types from wild to *in vitro* cultivation.

- **Wild** - not cultivated (e.g. all wild native, archeophytes and established aliens). Examples with economic interest include: forest trees; fungi; wild fruits; nuts; and

berries. A "semi-wild" subgroup (not cultivated but introduced in the wild by man) may qualify as a separate group.
- **Reservate** - not cultivated, but wild occurrence in a habitat or landscape that is not natural, or needs human input to prevent natural succession. More or less self-sufficient in a habitat that is not natural but needs maintenance (several subclasses). Examples include hazel in leaf meadows and many plants in rural landscapes.
- **Weedy** - not cultivated but follows man on ruderal soil or as pioneers of secondary succession where extensive human activity has disturbed the habitat. *Spergula arvensis, Agrostemma githago, Bromus secalinus.*
- **Silviculture** – perennial, cultivated and harvested plants, usually in monoculture with seedling, nursery, maintenance and harvest phases. *Pinus, Eucalyptys* and other forest trees.
- **Agriculture** - traditional agricultural fields with annual or biannual crops.
- **Horticulture** - gardens with annual or perennial plants usually in need of more care than in agricultural cultivation.
- **Orchard** - monoculture cultivation of perennial plants. *Prunus, Malus, Citrus, Vitis, Quercus*.
- **Parkland** - cultivated urban parks with extensive care.
- **Greenhouse** - cultivated with artificial light and heat. Tropical - subtropical plants outside their native regions.
- **Indoor** - indoor plants, mostly with ornamental usage.
- ***In vitro*** - utilization of plants cultivated in laboratory conditions (e.g. medicine production from Penicillus, Aspergillus, but also unrooted production cultures of higher plants).

Classification according to used plant parts

Classification based on what parts (if any) of the plants are harvested. Generally follows plant morphology.
- **Roots and tubers** - underground parts, either roots or underground stems - rhizomes and tubers. *Solanum tuberosum* (stem tuber), *Beta vulgaris var. altissima* (root)
- **Stem** - stems above ground. *Pinus, Linum*
- **Leaves** - or part of leaves, bulbs. *Allium, Rheum, Brassica oleracea*
- **Shoots** - stem & leaves. *Asparagus, Phleum*
- **Flower** - or flower parts. *Rosa, Crocus sativus*
- **Pollen/spores**. - *Salix, Taraxacum, Lycopodium*
- **Fruits** – botanical fruits & false fruits. *Malus, Ribes, Prunus, Fragaria*
- **Seeds** - *Triticum, Hordeum, Avena, Secale, Zea, Linum*
- **Bark** - *Quercus, Phellodendron*
- **Resins** – secreted actively by the plant. *Abies*
- **Saps** - intra-cellular. *Acer, Betula*

Classification according to derived substances

Classification based on the substances (if any) that are derived from the plants. Generally division follows the main chemical groups, i.e. carbohydrates, lipids and proteins, and secondary metabolites.
- **Sugar** – mono- and oligosaccharides. *Beta vulgaris* var. *altissima, Acer saccharinum*
- **Starch** - and other polysaccharides. *Triticum, Oryza, Zea, Hordeum, Sorghum, Avena, Secale, Solanum tuberosum, Helianthus tuberosus*
- **Fat, oil and waxes** - *Linum usitatissimum, Brassica rapa* ssp. *oleifera*
- **Proteins** - *Glycine max, Pisum, Phasaeolus, Triticum aestivum*
- **Minerals** – *Urtica dioica*

- **Vitamins** - or provitamins. *Citrus, Solanum, Daucus carota*
- **Wood** – xylem. *Pinus, Picea, Abies, Betula*
- **Fibre** – phloem. *Linum usitatissimum, Agave, Cannabis, Tilia, Gossypium*
- **Cork** – *Quercus, Phellodendron*
- **Secondary metabolites** - *Aconitum, Atropa, Hyosciamus, Erythroxylon, Digitalis, Nicotiana, Coffea*

Classification according to type of usage

- **Fresh food** - fresh food for humans. *Lactuca, Brassica oleracea*
- **Prepared food** - cooked food for humans. *Triticum, Phasaeolus*
- **Forage** - fresh food for animals (including bees). *Phleum, Poa, Trifolium*
- **Fodder** - prepared food for animals. *Hordeum, Avena, Pisum, Triticosecale*
- **Energy** - *Pinus, Picea, Abies, Betula, Phalaris*
- **Hygienic** - perfume, soap and other hygienic products. *Viola, Rosa, Lavandula*
- **Dyes** - *Reseda, Isatis*
- **Spices** - *Sinapis, Thymus, Humulus*
- **Medicinal** - *Digitalis, Papaver, Claviceps, Strychnos, Ricinus*
- **Stimulant** - *Nicotiana, Coffea, Camellia*
- **Poison** - *Chrysanthemum, Colchicum, Conium, Strychnos, Ricinus*
- **Ornamental** - too long a list to even think about giving examples
- **Industrial** - *Beta, Solanum, Pinus, Abies, Linum, Brassica rapa* ssp. *oleifera, Hordeum, Secale, Vitis*
- **Environmental** – used in environmental care, anti-erosion, water-cleansing, fertilising. *Carex, Elymus, Phalaris, Trifolium, Alnus, Hippophaë*
- **Building** - plants used to produce building material, objects, fabric, tools. *Pinus, Picea, Abies, Salix, Linum, Gossypium*

Non-exclusive classification in relation to taxonomic and regional classification

Not all culta of a given taxon exhibit the desirable features for a given usage. For example, certain barley types are not suitable for grain production, but are used solely as forage or fodder. The taxon *Hordeum vulgare* ssp. *vulgare* should be flagged as both a food plant and as a forage plant. On the cultonomic level, local types or commercial cultivars adapted to forage use should not be flagged as food plants, while grain production cultivars should. The same reasoning can be applied on an even lower level, for accessions. A collected local millet accession that reportedly was used solely for food should only be flagged for this use even if millet as a taxon has multiple uses.

On the taxon level then, information on the usage classes for a given taxon can be assembled in two ways:

- From a static database table into which the data was collected from literature sources or other references, or
- As a summary produced by adding the values from corresponding fields in tables from the lower (culton and accession) levels. (The method used is a “logical OR” operation, i.e. if one of the terms has a “true” value the result is “true”, otherwise it is “false”).

In the first case the information would show the overall potential of the taxon in question, while the second method would show the usage of the known cultivars and the conserved material. Different genebanks in the same region should arrive at the same result with the first method (and should in fact exchange and synchronise their static data tables) while the second method would show differences depending on the commercial cultivars and accessions actually stored.

Responsibility sharing between task forces

Neither the hierarchical, nor non-exclusive classification methods can avoid the conflicts that result from attempts to share the workload between task forces. For example, an organization may chose to establish a "cereal" working group to carry the responsibility for activities on cereal plants (e.g. wheat, barley, rice, maize), and a "forage" working group to care for forage plants (e.g. timothy, clover). Some crops, like barley, are then in both groups, which may lead to conflicts, duplicated efforts or oversights in planning and carrying out the workplan.

Table 3. Example of non-exclusive thematic descriptors

	Cultivation			**Parts Used**			**Substances**			**Type of Usage**		
Taxon	**A1**	**..**	**An**	**B1**	**..**	**Bn**	**C1**	**..**	**Cn**	**D1**	**..**	**Dn**
Taxon1	Y				Y		Y			Y	Y	
Taxon2		Y	Y			Y		Y			Y	Y
..	Y			Y	Y		Y			Y		Y
Taxon_n-1		Y				Y		Y		Y	Y	
Taxon_n		Y				Y		Y	Y		Y	

The relationship between the classification methods can be illustrated with a matrix where the exclusive (taxonomic) groups form rows and the non-exclusive usage groups form columns (Table 3). No matter how task forces are formed, with non-exclusive usage preferences (groups of columns), or exclusive taxonomic preferences (groups of rows), the task forces must consider plants flagged in all fields on the perpendicular axis. In other words, a "forage" task force should have a mandate for *all* taxa used as forages, and a "legumes" task force should have a mandate for *all* legumes (families *Fabaceae, Mimosaceae*), regardless of usage type. This of course will lead to duplicated efforts for "forage legumes", which must be resolved by an agreement between the task forces. If, instead of the "legumes" task force, separate "grain legumes" and "forage legumes" task forces are formed, then legume plants with neither forage nor grain usage may fall outside the scope of both groups.

Mixed taxonomic and thematic task forces seem to be common among organizations dealing with plant genetic resources. They also seem to be hard to avoid, especially since many organizations may have special regional or otherwise thematic interests that make certain usage groups less interesting than others, or even completely irrelevant for the region in question.

Organizations dealing with total coverage of the potential and the actual use of plant genetic resources may decide to periodically review the mapping of its task forces over the plant kingdom in order to balance the human and economic resources so that no group of plants is neglected. The ECP/GR Minor Crops Network can be considered a tool to complement the achievements of the other ECP/GR Networks and Working Groups and ensure that no plant group is overlooked.

The list of taxa provided with this article is generated from the taxonomic data table at the Nordic Gene Bank using criteria from a thematic descriptor table as outlined above. Most search criteria were taken from the "usage type". The purpose is to find the minimum list of taxa that are not yet included in any other ECP/GR Network or Working Group, but still important enough to be included as mandate species within the Minor Crops Network.

List of taxa used in Europe, extracted from the NGB taxonomic database

			FIB	SPI	MED	ORN	ENV	DYE	COS	IND
Aristolochiaceae	*Aristolochia clematitis*	65		S	M					
	Asarum europaeum	L.			M	O				
Ranunculaceae	*Aconitum napellus*	L.			M	O				
	Aconitum septentrionale	Koelle			M	O				
	Actaea erythrocarpa	Fischer			M	O				
	Actaea spicata	L.			M					
	Adonis vernalis	L.			M	O				
	Aquilegia vulgaris	L.			M	O				
	Consolida regalis	Gray			M	O				
	Nigella sativa	L.		S	M					
	Thalictrum flavum	L.						D		
Papaveraceae	*Chelidonium majus*	L.			M					
	Papaver bracteatum	Lindl.				O				I
	Papaver rhoeas	L.				O				I
	Papaver somniferum	L.			M	O				I
Fumariaceae	*Fumaria officinalis*	L.			M			D		
Cannabaceae	*Cannabis sativa*	L.	F		M					I
	Humulus lupulus	L.	F	S	M	O				I
Urticaceae	*Urtica dioica*	L.	F	S				D		I
Betulaceae	*Alnus glutinosa*	(L.) Gaertn.				O		D		
	Betula nana	L.				O		D		
	Betula pendula	Roth				O		D		I
	Betula pubescens	Ehrh.						D		
	Carpinus betulus	L.				O		D		
	Corylus avellana	L.				O				
Myricaceae	*Myrica gale*	L.		S	M			D		
Aizoaceae	*Tetragonia tetragonioides*	(Pallas) O. Kuntze								
Portulacaceae	*Portulaca oleracea ssp. sativa*	(Haw.) Celak		S						
Caryophyllaceae	*Agrostemma githago*	L.			M	O				I
	Gypsophila paniculata	L.			M	O				
	Herniaria glabra	L.			M					
	Saponaria officinalis	L.			M	O				
	Spergula arvensis ssp. maxima	(Weihe) O. Schwartz								
Amaranthaceae	*Amaranthus caudatus*	L.				O				
Chenopodiaceae	*Atriplex hortensis*	L.								
	Chenopodium ambrosioides	L.			M					
	Chenopodium bonus-henricus	L.			M					
	Spinacia oleracea	L.								
Polygonaceae	*Fagopyrum esculentum*	Moench								
	Fagopyrum tataricum	(L.) Gaertn.								
	Polygonum bistorta	L.			M	O				
	Polygonum hydropiper	L.		S	M			D		
	Rheum palmatum	L.			M	O				
	Rheum x hybridum	Murray								
Paeoniaceae	*Paeonia officinalis*	L.			M	O				
Clusiaceae	*Hypericum perforatum*	L.		S	M			D		I
Violaceae	*Viola odorata*	L.			M	O			H	I
	Viola tricolor	L.			M	O				
Cucurbitaceae	*Bryonia alba*	L.			M	O				
	Cucumis melo	L.								
	Cucumis sativus	L.								
	Cucurbita pepo	L.				O				
Brassicaceae	*Alliaria petiolata*	(M. Bieb.) Cavara & Grande		S						
	Armoracia rusticana	Gaertn. *et al.*		S	M					
	Camelina alyssum	(Mill.) Thell.								I

	Camelina sativa ssp. pilosa	DC.						I
	Camelina sativa ssp. sativa	(DC.) Fritsch						I
	Cochlearia officinalis	L.		S	M			
	Conringia orientalis	(L.) Dumort.			M			
	Crambe abyssinica	Hochst. ex R. E. Fr.						I
	Crambe maritima	L.				O		I
	Eruca sativa	Mill.		S				
	Isatis tinctoria	L.					D	I
	Lepidium sativum	L.		S				
	Nasturtium officinale	R. Br.		S	M			
	Raphanus raphanistrum	L.						I
	Raphanus sativus var. acanthiformis							
	Raphanus sativus var. longipinnatus	L. H. Bailey						
	Raphanus sativus var. niger	J. Kern.		S				
	Raphanus sativus var. oleifera							
	Raphanus sativus var. sativus							
	Sinapis alba	L.		S	M			I
	Sinapis arvensis	L.						I
	Sisymbrium officinale	(L.) Scop.			M			
Resedaceae	*Reseda luteola*	L.					D	I
	Reseda odorata	L.			M	O		
Salicaceae	*Salix pentandra*	L.	F		M		D	I
Ericaceae	*Andromeda polifolia*	L.		S				
	Arctostaphylos uva-ursi	(L.) Spreng.			M		D	
	Calluna vulgaris	(L.) Hull		S		O	D	
	Ledum palustre	L.		S	M	O		
	Vaccinium myrtillus	L.		S			D	
	Vaccinium vitis-idaea	L.						
Primulaceae	*Lysimachia vulgaris*	L.				O	D	
	Primula elatior	(L.) Hill			M	O		
	Primula veris	L.		S	M	O		
Tiliaceae	*Tilia cordata*	Mill.	F	S	M	O		
Malvaceae	*Abutilon theophrasti*	Medik.	F					
	Althaea officinalis	L.			M	O		
	Malva	L.	F					
	Malva neglecta	Wallr.			M			
	Malva parviflora	L.						
	Malva sylvestris	L.			M	O		
Euphorbiaceae	*Euphorbia cyparissias*	L.			M	O		
	Euphorbia lathyris	L.			M			
	Mercurialis perennis	L.			M			
Thymelaeaceae	*Daphne mezereum*	L.			M	O		
Crassulaceae	*Sedum acre*	L.		S	M			
	Sedum rosea	(L.) Scop.			M			
	Sedum telephium	L.			M	O		
	Sempervivum tectorum	L.			M	O		I
Grossulariaceae	*Ribes nigrum*	L.			M			
	Ribes rubrum	L.						
	Ribes uva-crispa	L.						
Droseraceae	*Drosera rotundifolia*	L.			M			
Rosaceae	*Agrimonia eupatoria*	L.			M			
	Agrimonia procera	Wallr.			M			
	Alchemilla	L.					D	
	Crataegus	(Walter) Torr. & A. Gray		S				
	Cydonia oblonga	Mill.			M	O		
	Dryas octopetala	L.			M	O		
	Filipendula ulmaria	(L.) Maxim.		S	M			

	Fragaria moschata	Duchesne							
	Fragaria vesca	L.							
	Fragaria viridis	Duchesne							
	Fragaria x ananassa	Duchesne							
	Geum urbanum	L.		S	M				
	Potentilla erecta	(L.) Raeusch.		S	M				
	Rosa canina	L.			M	O			
	Rosa rubiginosa s. lat.	L.				O			
	Rubus arcticus nothossp. stellarcticus	G. Larsson							
	Rubus arcticus ssp. arcticus	L.							
	Rubus caesius	L.							
	Rubus chamaemorus	L.							
	Rubus fruticosus	L., sensu typo			M				
	Rubus idaeus	L.		S	M				
	Rubus laciniatus	Willd.							
	Rubus saxatilis	L.							
	Sanguisorba minor	Scop.		S		O			
	Sanguisorba officinalis	L.		S	M	O			
	Sorbus aucuparia	L.		S		O			
	Sorbus teodori	Liljefors							
Fabaceae	*Anthyllis vulneraria*	L.				O	D		
	Cytisus scoparius	(L.) Link	F			O			
	Galega officinalis	L.			M				
	Genista tinctoria	L.				O	D		I
	Glycine max	(L.) Merr.							
	Glycyrrhiza glabra	L.			M	O			
	Lens culinaris	Medik.							
	Lupinus angustifolius	L.							
	Lupinus luteus	L.							
	Lupinus nootkatensis	Donn ex Sims				O			
	Lupinus polyphyllus	Lindl.				O			
	Melilotus alba	Medicus	F						
	Melilotus officinalis	Lam.			M				
	Ononis arvensis	L.			M	O			
	Tetragonolobus maritimus	(L.) Roth							
	Tetragonolobus purpureus	Moench							
	Tetragonolobus siliquosus	Roth							
	Trigonella foenum-graecum	L.		S	M				
Caesalpiniaceae	*Cassia fistula*	L.			M	O			
Lythraceae	*Heimia salicifolia*	(Kunth) Link			M				
	Lawsonia inermis	L.			M	O			
	Lythrum salicaria	L.			M	O			
Onagraceae	*Circaea alpina*	L.			M	O			
	Circaea intermedia	Ehrh.			M	O			
	Circaea lutetiana	L.			M	O			
	Epilobium angustifolium	L.	F	S	M				
	Oenothera biennis	L.			M				I
Rutaceae	*Dictamnus fraxinella*				M	O			
	Ruta graveolens	L.		S		O			
Linaceae	*Linum usitatissimum*	L.	F		M				I
Oxalidaceae	*Oxalis acetocella*	L.			M				
Geraniaceae	*Geranium sylvaticum*				M	O			
Polygalaceae	*Polygala amarella*				M				
Apiaceae	*Aegopodium podagraria*	L.		S	M	O			
	Anethum graveolens	L.		S	M				
	Angelica archangelica ssp. archangelica	L.		S	M				
	Angelica sylvestris	L.					D		
	Anthriscus cerefolium	(L.) Hoffm.		S					

	Anthriscus sylvestris	(L.) Hoffm.					D	
	Apium graveolens	L.		S	M			
	Carum carvi	L.		S	M			
	Cicuta virosa	L.			M			
	Conium maculatum	L.			M			
	Coriandrum sativum	L.		S				
	Cuminum cyminum	L.		S				
	Daucus carota ssp. sativus	(Hoffm.) Arcangeli.						
	Eryngium campestre	L.			M			
	Eryngium maritimum	L.			M	O		
	Ferula foetida	(Bunge) Regel			M			
	Foeniculum vulgare	Mill.		S				
	Levisticum officinale	W. D. J. Koch		S	M			
	Meum athamanticum	Jacq.		S	M			
	Myrrhis odorata	(L.) Scop.		S				
	Pastinaca sativa	L.		S				
	Petroselinum crispum	(Mill.) Nyman ex A. W. Hill		S	M			
	Peucedanum ostruthium	(L.) W. D. J. Koch		S	M			
	Pimpinella anisum	L.		S				
	Pimpinella major	(L.) Huds.			M			
	Pimpinella saxifraga	L.			M			
	Sanicula europaea	L.			M			
	Smyrnium olusatrum	L.		S				
Araliaceae	*Acanthopanax senticosus*	(Rupr. & Maxim.) Harms			M	O		
	Hedera helix	L.		S	M	O		
Aquifoliaceae	*Ilex aquifolium*	L.		S		O		
Rhamnaceae	*Rhamnus cathartica*	L.			M	O	D	
	Rhamnus frangula	L.			M	O	D	
Elaeagnaceae	*Hippophaë rhamnoides*	L.				O	D	
Rubiaceae	*Galium boreale*	L.				O	D	
	Galium odoratum	(L.) Scop.		S	M			
	Galium tinctoria						D	
	Galium verum	L.		S		O		I
Apocynaceae	*Vinca minor*	L.			M	O		I
Asclepiadaceae	*Vincetoxicum hirundinaria*	Medik.	F		M			
Gentianaceae	*Centaurium erythraea*	Rafn		S	M			
	Centaurium littorale	(Turner) Gilmour			M			
	Centaurium minus	auct.			M			
	Gentiana lutea	L.		S	M			
	Gentiana purpurea	L.		S	M	O		
Menyanthaceae	*Menyanthes trifoliata*	L.		S	M	O		
Loranthaceae	*Viscum album*	L.			M			
Caprifoliaceae	*Sambucus ebulus*	L.		S	M		D	
	Sambucus nigra	L.		S	M	O	D	
Valerianaceae	*Valeriana officinalis*	L.			M	O		
	Valerianella locusta	(L.) Laterr.						
Dipsacaceae	*Succisa pratensis*	Moench		S		O	D	
Boraginaceae	*Anchusa officinalis*	L.			M			
	Borago officinalis	L.		S	M			
	Cynoglossum officinale	L.			M			
	Lithospermum officinale	L.			M			
	Pulmonaria officinalis	L.		S	M	O		
	Symphytum officinale	L.			M			
Lamiaceae	*Agastache foeniculum*	(Pursh) Kuntze		S		O		
	Agastache scrophulariaefolia			S				
	Glechoma hederacea	L.		S	M			
	Hyssopus officinalis	L.		S	M	O		
	Lamium album	L.			M			

	Lavandula angustifolia	Mill.	S	M	O			
	Leonurus cardiaca	L.		M				I
	Lycopus europaeus	L.				D		
	Marrubium vulgare	L.		M				
	Melissa officinalis	L.	S	M				
	Mentha aquatica	L.	S	M	O			
	Mentha arvensis	L.	S	M	O			
	Mentha crispa	L.	S	M				
	Mentha longifolia	(L.) Huds.	S	M	O			
	Mentha pulegium	L.	S	M				
	Mentha spicata	L.	S	M	O			
	Mentha suaveolens	Ehrh.	S	M				
	Mentha x gentilis	auct.	S	M	O			
	Mentha x piperita	L.	S	M				
	Monarda citriodora	Cerv. ex Lag.	S					
	Monarda didyma	L.	S		O			
	Monarda fistulosa	L.	S					
	Nepeta cataria	L.		M				
	Ocimum basilicum	L.	S					
	Ocimum citriodora		S					
	Ocimum sanctum	L.	S					
	Origanum heracleoticum (vulga		S					I
	Origanum laevigatum		S					
	Origanum majorana	L.	S					
	Origanum vulgare	L.	S	M	O	D		
	Perilla frutescens	(L.) Britton	S		O			
	Pycnanthemum tenuifolium	Schrad.	S					
	Rosmarinus officinalis	L.	S					
	Salvia officinalis	L.	S	M				
	Salvia pratensis	L.	S					
	Salvia sclarea	L.		M	O			
	Satureja acinos	(L.) Scheele	S					
	Satureja calamintha	(L.) Scheele	S					
	Satureja hortensis	L.	S					
	Satureja montana	L.	S					
	Satureja vulgaris	(L.) Fritsch	S					
	Stachys officinalis	(L.) Trevis.		M	O			
	Stachys sylvatica	L.				D		
	Teucrium chamaedrys	L.		M				
	Teucrium scordium	(Schreb.) Arcang.		M	O			
	Thymus caespititius	Brot.	S	M	O			
	Thymus citriodorus		S		O			
	Thymus pulegioides	L.	S	M	O			
	Thymus serpyllum ssp. serpyllum	L.	S	M	O			I
	Thymus vulgaris	L.	S	M				
Verbenaceae	*Verbena officinalis*	L.		M				
Solanaceae	*Atropa belladonna*	L.		M	O			
	Capsicum annuum	L.	S		O			
	Capsicum frutescens	L.	S					
	Datura stramonium	L.		M	O			
	Hyoscyamus niger	L.		M				
	Lycopersicon esculentum	Mill., nom. cons.						
	Nicotiana tabacum	L.		M	O			
	Physalis alkekengi	L.	S		O			
	Scopolia carniolica	Jacq.		M				
	Solanum dulcamara	L.		M				
	Solanum nigrum	L.		M				
	Solanum tuberosum	L.		M				I

Scrophulariaceae	*Cymbalaria muralis*	P. Gaertn. *et al*.		M	O		
	Digitalis purpurea	L.		M	O		
	Euphrasia rostkoviana	Hayne		M			
	Euphrasia rostkoviana ssp. rostkoviana	Hayne		M			
	Gratiola officinalis	L.		M			
	Verbascum densiflorum	Bertol.		M	O		
	Verbascum lychnitis	L.		M			
	Verbascum nigrum	L.		M	O		
	Verbascum phlomoides	L.		M			
	Verbascum thapsus	L.		M			
	Veronica anagallis-aquatica	L.					
	Veronica officinalis	L.		M			
Plantaginaceae	*Plantago afra*	L.	S				
	Plantago lanceolata	L.		M			
	Plantago major	L.		M			
Asteraceae	*Achillea millefolium*	L.	S	M	O		
	Anthemis cotula	L.		M			
	Anthemis tinctoria	L.			O	D	
	Arctium lappa	L.		M	O		
	Arctium minus	(Hill) Bernh.		M			
	Arnica montana	L.	S	M	O		
	Artemisia abrotanum	L.	S	M			
	Artemisia absinthium	L.	S	M	O		
	Artemisia annua	L.	S		O		
	Artemisia cina	O. Berg		M			
	Artemisia dracunculus	L.	S				
	Artemisia maritima	L.		M			
	Artemisia vulgaris	L.	S	M			
	Bellis perennis	L.		M	O		
	Bidens tripartita	L.				D	
	Calendula officinalis	L.	S	M	O		
	Carlina acaulis			M	O		
	Centaurea cyanus	L.		M	O		
	Centaurea jacea	L.		M	O	D	
	Centaurea scabiosa	L.		M	O		I
	Chamaemelum nobile	(L.) All.		M	O		
	Chrysanthemum coronarium	L.	S		O		
	Chrysanthemum parthenium	(L.) Bernh.		M	O		
	Cirsium helenioides	(L.) Hill		M		D	
	Cnicus benedictus	L.	S	M			
	Cynara scolymus	L.					
	Eupatorium cannabinum	L.		M	O		
	Helianthus annuus	L.			O		I
	Helianthus tuberosus	L.			O		I
	Helichrysum arenarium	(L.) Moench		M	O		
	Inula helenium	L.		M	O		
	Matricaria recutita	L.	S	M			
	Onopordum acanthium	L.		M			
	Petasites hybridus	(L.) P. Gaertn. *et al.*		M			
	Rudbeckia purpurea	L.		M			
	Santolina chamaecyparissus	L.	S				
	Santolina rosmarinifolia	L.	S		O		
	Serratula tinctoria					D	
	Silybum marianum	(L.) Gaertn.		M	O		
	Solidago virgaurea	L.		M	O		
	Tanacetum vulgare	L.		M	O	D	
	Tussilago farfara	L.		M			
Cichoriaceae	*Cicerbita alpina*	(L.) Wallr.		M			

	Cichorium endivia var. crispum	Lam.							
	Cichorium endivia var. latifolium	Lam.							
	Cichorium intybus	L.			M				
	Hieracium umbellatum	L.				O		D	
	Lactuca sativa var. angustana	L. H. Bailey							
	Lactuca sativa var. capitata	L.							
	Lactuca sativa var. crispa	L.							
	Lactuca sativa var. longifolia	Lam.							
	Scorzonera hispanica	L.							
Scrophulariaceae	*Scrophularia nodosa*	L.			M				
Cichoriaceae	*Taraxacum*	(Ledeb.) DC.			M				
Convallariaceae	*Polygonatum multiflorum*	(L.) All.			M	O			
	Polygonatum odoratum	(Mill.) Druce			M				
Asparagaceae	*Asparagus officinalis*	L.							
Melanthiaceae	*Veratrum album*	L.			M				
Liliaceae	*Colchicum autumnale*	L.			M	O			
	Convallaria majalis	L.			M	O			H
	Lilium candidum	L.			M	O			
Iridaceae	*Iris germanica*			S	M	O			
	Iris pseudacorus	L.			M	O			
Orchidaceae	*Dactylorhiza maculata*	(L.) Soó			M				
	Dactylorhiza majalis	(Reichenbach) P.F. Hunt			M				
Araceae	*Acorus calamus*	L.		S	M				
	Ambrosina mexicana			S		O			
	Arum maculatum	L.			M				
Cyperaceae	*Eriophorum angustifolium*		F			O			
	Eriophorum vaginatum	L.	F			O			
Poaceae	*Ammophila arenaria*	(L.) Link				O	E		
	Anthoxanthum odoratum	L.		S		O			
	Calamagrostis canescens	(Weber ex F. H. Wigg.) Roth						D	
	Elymus alaskanus	(Scribn. & J. G. Sm.) A. Love							
	Elymus caninus	(L.) L.							
	Elymus farctus	(Viv.) Runemark ex Melderis				O	E		
	Elymus fibrosus	(Schrenk) Tzvelev							
	Elymus mutabilis	(Drobow) Tzvelev							
	Elymus pungens	(Pers.) Melderis							
	Elymus repens	(L.) Gould		S					
	Elymus trachycaulus	(Link) Gould ex Shinners							
	Glyceria fluitans	(L.) R. Br.							
	Glyceria maxima	(Hartm.) Holmb.				O			
	Hierochloë odorata	(L.) P. Beauv.		S					
	Hordelymus europaeus	(L.) Harz							
	Leymus arenarius	(L.) Hochst.				O	E		
	Phragmites australis	(Cav.) Trin. ex Steud.						D	I
	x Ammocalamagrostis baltica	(Flugge ex Schrad.) P. Fourn.				O	E		

Abbreviations
FIB = Fibre
SPI = Spice
MED = Medicinal
ORN = Ornamental
ENV = Environmental
DYE = Dye
COS = Cosmetic
IND = Industrial

Minor Cereals and Pseudocereals in Europe

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Introduction

There are at least 12 500 species of vascular plants in Europe, of which 3 500 are endemic. The *Poaceae* family, which includes all cereals, is represented by 880 species (IPGRI, FAO, 1996). In Europe, the primary centre of crop diversity was the Mediterranean area, however, there are also secondary centres of diversity for cereal species brought here from their places of origin. These have been further diversified through the selection work of farmers. Crops such as rye and oats from the Near East and Mediterranean may have been introduced as weeds to northern Europe. They were domesticated in barley and wheat fields and developed during ancient times. Major cereals (wheat, barley, and rye) are the most important crops grown in Europe, but this region is also home to many minor cereals.

The development of agriculture from traditional farming systems to modern types of cultivation has been important for the progress of rural regions. This process has been the direct cause of the replacement of traditional varieties and landraces with improved high yielding ones. A few crops suitable for large scale crop production replaced many extensive minor crop species. These crops, which are currently underutilized, were very much used in the past, as evidenced by both historical records of cropping patterns and dietary habits. Small grain crops - hulled wheats, millets, buckwheat and sorghum - held an important position as a staple food for certain regions and their cultivation was very popular.

Table 1. Open list of minor cereals and pseudocereals in Europe suggested for the attention of the ECP/GR Minor Crops Network

Crops/species	***Botanical name***
Cereals:	
Hulled wheats	
1 Einkorn	*Triticum monococcum* L.
2 Emmer	*Triticum dicoccon* Schrank (Schuebl.)
3 Spelt wheat	*Triticum spelta* L.
Other wheats species	
4 Polish wheat	*Triticum polonicum* L.
5 Club wheat	*Triticum compactum* Host.
6 Turgidum wheat	*Triticum turgidum* L.
7 Carthlicum wheat	*Triticum carthlicum* Nevski
8 Macha wheat	*Triticum macha* Dekapr. et Menabde
Rye	
9 Semiperenial rye	*Secale cereale* L., var. *multicaule* Metzg.
Barley	
10 Naked barley	*Hordeum vulgare* L., subsp. *distichon* (L.) Koern., var. *nudum* L.
Oat	
11 Naked oat	*Avena nuda* L.
Sorghum and millets	
12 Sorghum	*Sorghum bicolor* (L.) Moench
13 Common millet	*Panicum miliaceum* L.
14 Foxtail millet	*Setaria italica* (L.) P. Beauv.
15 Barnyard millet	*Echinochloa frumentacea* (Roxb.) Link.
16 Foxglove	*Digitaria sanguinalis* (L.) Scop.
Pseudocereals:	
Buckwheat	
17 Common buckwheat	*Fagopyrum esculentum* Moench
18 Tartary buckwheat	*Fagopyrum tataricum* (L.) Gaertn.

The cereal species of high local importance in the history of Europe were selected as a group of minor or underutilized crops upon which the ECP/GR Minor Crops Network could focus its attention (Table 1). Many of them have a high nutritional value and excellent properties and could become a basic source for diversifying European agriculture and food. This non-exhaustive list could be modified and completed on the basis of other proposals.

Hulled wheats

Einkorn (*Triticum monococcum*), emmer (*Triticum dicoccon*), spelt (*Triticum spelta*)

Introduction

Hulled wheat species (einkorn, emmer and spelt) are among the most ancient cereal crops of the Mediterranean region (Perrino *et al.* 1996). These cereals were popular within the region for hundreds of years and remained a staple food for a long time. At a certain point in time they fell into a state of abandonment. At present, hulled wheats are becoming popular again. In Italy, 'farro', which is a collective name for einkorn, emmer and spelt, is gaining farmers' interest due to its high commercial potential. The industrial sector is also looking to 'farro' for its potential in the production of pasta, biscuits and other products. In many areas of the southern Apennines, emmer and einkorn are still used to feed animals and are linked with the low-level agricultural systems still practiced there. The cultivation of native hulled wheats is restricted to marginal mountain areas with poor soil in eastern Europe, Albania, Austria, Greece, Italy and Spain. Emmer and einkorn are still being cultivated in Turkey and in 1993 the sown area of hulled wheat there was 12 900 ha.

Activities on genetic resources of hulled wheats

To promote conservation of hulled wheats and to safeguard them from erosion, in 1993 IPGRI initiated a project on underutilized Mediterranean species (UMS) which included hulled wheats. In 1994 a working group and The Network on Obsolete Wheat Species were established (Padulosi *et al.* 1995). The members of the working group recommended the formulation of a Regional Project on 'Obsolete Wheat Species' with the following objectives:

- Promote the conservation and enhance the genetic diversity of landraces of these species;
- Promote research on and development of landraces of the selected species;
- Encourage farmers, NGOs, cooperatives, etc. to conserve and promote the utilization of landraces of these species;
- Develop new products and promote the use of health/special foods from these species.

These activities proved very fruitful. The UMS project has contributed to raising the interest of both growers and scientists on hulled wheats with a beneficial impact on their conservation (Padulosi *et al.* 1996). The UMS project is considered a model for the establishment of other new subregional cooperation projects for the conservation and sustainable use of underutilized species.

Ex-situ conservation

A summary of hulled wheats germplasm holdings deposited in European genebanks is given in Table 2. Among the wheats, *Triticum dicoccon* is the most represented species and more than 50% are accessions of landraces or traditional cultivars.

Table 2. Summary of hulled wheats records included in the European Wheat Database

Hulled wheat species	Records	Traditional cultivar / landrace	Advanced cultivars
Triticum monococcum	648	143	11
Triticum dicoccon	1042	615	33
Triticum spelta	579	267	55
Total	**2269**		

Successful collecting missions should be conducted in the countries of origin or in any other place where an ancient tradition of hulled wheats survives (Balkan countries, Italy and Turkey). According to Holubec (1999) einkorn and spelt wheats are probably no longer available but collecting cultivated emmer should still be a possibility. A relic cultivation was practiced in the White Carpathian Mountains on the border of the Czech Republic and Slovakia in the 1970s (Hanelt and Hammer 1975).

In-situ conservation

In Italy, on-farm conservation of hulled wheats is being successfully developed. The Tuscany region promoted its own programme for both *ex situ* and *in situ* germplasm conservation. Twenty-three emmer accessions from Garfagnana and four einkorn accessions from southern Tuscany are currently preserved at the Regional Germplasm Bank. Twenty-three farmers from Garfagnana provided characterized 'farro' samples and their *in situ* reproduction (Vazzana 1996).

Spain has promoted the conservation of einkorn cultivation in Andalucia since 1992, where it continues to be grown. No initiatives are available for conservation of emmer and spelt cultivation in the Asturias region (Peña-Chocarro 1996).

A German farmers' cooperative in the northern part of Bavaria preserves einkorn on several hectares and handles the marketing (Müller 1999).

The Swiss Non Government Organization "Pro Specie Rara" preserves more than 400 varieties of more than 70 species including hulled wheats.

In Georgia, the biological farming association "Elkana" aims to promote biofarming and self-help development in Georgia. Einkorn was widely used there in the past. Bread baked with 'Zanduri' flour (*Triticum monococcum*), called Kings' bread was used for festive and ritual purposes because of its high quality (Nemsadze 1999).

In the Czech Republic, on-farm conservation of emmer is in the preliminary stages and will probably start in 2000.

Other minor wheat species

At present, mainly organic farmers grow other species of wheat, which can be used for special food production. The following wheat species were recommended for the attention of the Network:

Polish wheat (*Triticum polonicum*)

Tetraploid wheat was grown in southern Europe (Mediterranean region) as it requires a warm climate. Many forms having large grains and a high protein content (27%), were used for bread making (Dorofeev 1987).

Turgidum wheat (*Triticum turgidum*)

In Europe, turgidum wheat grew mainly in the Mediterranean region (Balkan countries, Italy, south of France, Spain), England, Germany and Switzerland. In central Europe, a well known variety of *Triticum turgidum* 'Riwett's wheat' was

grown. It was the most productive variety of all wheats grown there but not suitable for use in baking.

Club wheat (*Triticum compactum*)

Hexaploid free-threshing wheat of European primeval ages, grown in Alpine countries, Austria, Switzerland and southern Europe had a high protein content (22%) and was excellent for baking (Dorofeev 1987). It was used for bread making.

Macha wheat (*Triticum macha*)

This hulled hexaploid wheat is endemic to the Caucasus area where it was discovered in 1929. In Georgia, a popular local variety 'Makha' that had stable yields in different climatic conditions and a high resistance to various diseases, was grown until the 1930s. However, during the collection process it was replaced by the high yielding variety *Triticum aestivum*.

Another wheat grown in Georgia was **carthlicum wheat (*Triticum carthlicum*).**

***Ex situ* and *in situ* conservation**

The European Wheat Database presents the following numbers of holdings in European genebanks (Table 3). *In situ* conservation is probably not currently practiced in Europe.

Table 3. *Ex-situ* conservation in Europe (EWDB)

Selected minor wheat species	Total Records	Traditional cultivar/landrace	Advanced cultivars
Triticum polonicum	174	82	9
Triticum turgidum	830	483	91
Triticum compactum	817	348	100
Triticum macha	91	42	0
Triticum carthlicum	197	124	5

Rye

Semi-perennial rye (*Secale cereale,* var. *multicaule*)

Semi-perennial rye was grown in central European countries (Austria, Czech Republic, Germany, Poland and Slovakia). In former Czechoslovakia it was called *"kribica"* (Marian / St.John's rye, Forest / Czech Mountain rye, Valaske rye, Russian / North-German rye). Farmers on the Czech-Slovak border sowed it in June or July in forest clearings. In the first year, many sterile shoots were formed and used as fodder for domestic animals or for feeding of wild game. In the second year farmers harvested the grains, produced flour and used it for baking bread which was very popular because it was resistant to mould and it remained soft for over a week. This type of rye is used by hunting associations for fodder for wild animals. Organic farmers are interested in its cultivation for food purposes.

Naked barley

Hordeum vulgare,* ssp. *distichon,* var. *nudum
Hordeum vulgare,* ssp. *vulgare,* var. *coeleste

Naked barley was known throughout Europe but the largest cultivated area was in the Alpine region, Belgium and Norway. It was very popular in the Oriental and Himalayan regions. Worldwide, hulled barley is a major crop, but naked barley is

underutilized. Its wider use is in regions of traditional barley consumption (Ethiopia, Japan and Nepal).

Today, there is a demand for naked barley in America, Australia, Canada and in some European countries (Czech Republic, Germany). Naked barley does not need special growing conditions; some landraces and obsolete cultivars could be successfully grown in low-input systems. Endemic Georgian naked barley was found during the expedition in Tusheti and was subsequently reproduced by an organic farmer (Nemsadze 1999). It has a high yield and it is easy to process. Barley porridge is very tasty, nutritious and easy to cook, so it could be included in children's diets.

Ex situ and *in situ* conservation

The Czech barley collection holds only six accessions of naked barley (total holding: 3974 barley accessions). In the Czech Republic, no cultivar of naked barley has been registered yet but many promising breeding lines with a different nutritional value have been developed.

Naked oat

***Avena nuda* L. (*Avena sativa*, var. *nuda*)**

Within Europe, naked oat was mainly grown in Austria, Belgium, Denmark, Germany, England and former Czechoslovakia. It is suitable for dry conditions and poor and heavier soils. Naked seeds are easy to thresh. The whole grains can be cooked. Naked oat can substitute rice and is very tasty. It can also be ground into flour and used as a cereal in all the ways that oats can be used (porridge, biscuits, bread, etc.). The seeds can also be sprouted and eaten raw or cooked in salads, stews etc. The roasted seeds could be used as a coffee substitute. The straw has a wide range of uses such as for biomass, fibre and paper production.

Ex situ and *in situ* conservation

Very little information is available on the germplasm of naked oat. About 20 accessions are maintained in European genebanks. The Czech oat collection includes eight accessions of *Avena nuda*. Some of them were used in breeding. Two registered domestic varieties of naked oats 'Abel' (1994) and 'Izak' (1998) are cultivated in conventional and organic agricultural systems. No information about *in situ* conservation in Europe is currently available.

Sorghum and millets

Sorghum (*Sorghum bicolor*), Common millet (*Panicum miliaceum*), Foxtail millet (*Setaria italica*)

Introduction

Sorghum and millets are still the most important staple foods in the semi-arid tropics of Asia and Africa. They are grown in harsh environments where other crops grow or yield poorly. They often grow with limited water resources and usually without any fertilizers or other input. They are often referred to as "coarse grain" and "poor peoples' crops".

Distribution and production

Only 1% of the total world production of sorghum is grown in Europe. Sorghum cultivation is limited to a few areas in France, Italy, Spain and southeastern countries.

Table 4 provides data on the area, yield and production of sorghum in various regions of Europe. Sorghum is extensively cultivated in Russia (0.6 t/ha) and the Ukraine (0.7 t/ha). France, Italy and Spain produce the highest quantity of sorghum (91% of total European production) because of both growing area and higher yield per unit area. Sorghum is used for two distinct purposes: human consumption and animal fodder. Nutritionally it is comparable with other grains.

Table 4. Sorghum and millets production in Europe – 1998 (FAO, 1999)

	Sorghum			***Millet***		
Country	**Harvest area (ha)**	**Yield (t/ha)**	**Production (t)**	**Harvest area (ha)**	**Yield (t/ha)**	**Production (t)**
Albania	15000	0.933	14000			
Czech Republic				2000	2.500	5000
Croatia	1000	4.180	1000			
France	65000	6.108	397000			
Greece	1000	2.000	2000			
Hungary	5000	2.141	11000	8000	1.432	12000
Italy	30000	5.558	168000			
Moldova Rep.						
Romania	7000	1.664	11000			
Russian Federation	20000	0.600	12000	960000	0.469	450000
Slovakia				1000	1.500	1000
Spain	11000	4.828	53000		3.500	1000
Ukraine	7000	0.714	5000	214000	1.160	249000
Yugoslavia F.R.	2000	3.219	5000			
Europe	163000	4.162	679000	1186000	0.606	718000

'Proso' was an ancient Slavic name for common millet used in Russia, former Czechoslovakia, Slovenia and Poland. It has also been called hog millet, broomcorn millet, Russian millet and brown millet. This millet is of ancient cultivation. It is believed to have been domesticated in central and eastern Asia and because of its ability to mature quickly, nomads often grew it. It was cultivated by the early Lake Dwellers in Europe. Its remains from here and other European archeological sites indicate that the crop was cultivated in Europe during the third millennium BC. It was also grown in parts of the Mediterranean region, the Balkans, Caucasus and Turkey. Common millet has one of the lowest water requirements of any cereal and can be grown on the poorest of soils.

Foxtail millet is also known as Italian, German, Hungarian or Siberian millet. It is believed to have been one of the five sacred plants of ancient China. Foxtail millets recovered in southern European sites were dated back to the third millennium BC. *S. italica* is not known in the wild state except as a weed which escaped from cultivation. Germplasm exchange between Europe and Asia could have been taking place for at least two millennia and this has somewhat masked the evolutionary history of the crop in its European and Asiatic centres of variability.

In central Europe, common and foxtail millets were a staple food of the ancient Slavs. They cooked the dehulled millet groats as porridge. Foxtail millet groats were ground in flour and used for bread making. Up to the last century, millet growing was very popular in central Europe, then the areas of cultivation diminished as other crops replaced millet. Throughout Europe and elsewhere there was an extreme decrease in production following World War II. Nemsadze (1999) states that '*Gomis Gomi*' (porridge), one of the main foods of the West Georgians, was also forgotten because the Italian millet with a high nutritive quality was lost. It was replaced by maize.

Minor millets account for less than 1% of the food grains produced in the world today (FAO 1995). Thus they are not important in terms of world food production,

but they are essential as food crops in their respective agro-ecosystems. They are mostly grown in marginal areas or under agricultural conditions where major cereals fail to give sustainable yields.

The Russian Federation and Ukraine produce over 97% of the total European production of millets (Table 4).

Ex situ conservation

The largest collections of sorghum and millets are mainly held in the countries of traditional consumption and breeding activities (Table 5). The highest number of accessions of sorghum is concentrated in Russia and France. The largest collections of millets are in Russia, Ukraine and France.

Table 5. List of European Institutions holding sorghum and millets

		Number of accessions				
Country	**Institute**	***Sorghum bicolor***	***Sorghum* spp.**	***Panicum miliaceum***	***Panicum* spp.**	***Setaria* spp.**
Albania	Forage Res. Instit. Fushë-Krujë		44			
	Agric. Univ. of Tirana	8				
Austria	National Ist. for PB & ST, Rinn	10				
Bulgaria	IPIGR, Sadovo	589				
Czech Republic	RICP, Prague - Ruzyne	1	2	160	9	23
France	INRA, Lusignan	500				
	CIRAD-CA, Montpellier		1746			
	ORSTOM, Montpellier	3859		533		3500
	INRA, Pointe – A - Pitre	143				
	UEM, Surgeres	512	112			
Germany	ICS, FRCA, Braunschweig	65	13			
	IPG, Gatersleben	71	35	94	7	122
	University of Kassel, Witzenhausen	1				
Greece	Gene bank, Thermi-Thessaloniky	2				
Hungary	IA, Tapioszele		985	250		
	RIVC, Ujmajori Budapest	20	73	50		
	Univ.of Agric.Scienes, Kompolt				1	
Israel	Israel Gene bank, Bet Dagan	90	150	26		
Italy	Germplasm Inst. CNR, Bari	50				
Poland	PBAI, Radzikow				256	88
	BGPBAI, Bydgoszcz			342	3	84
Portugal	BPGV, Braga			10		9
Romania	RICIC, Fundulea		72	274		
	Gene bank of Sucaeva	11	9			
Russia	RIPI, St.Petersburg	9892		8847	25	4749
Slovakia	SAU, Nitra		10		3	4
	RICP, Piestany	2	2	8		
Spain	INITAA, Alcala de he Nares	42		3		4
Turkey	AARI, Izmir	87		8		
Ukraine	YIPB, Kharkov			850		
	UES,Ustimovka			3567		
Yugoslavia, F.R.	MRI, Belgrade -2E Mun	30		15		
	IFVC, Facul. of Agric., Novi Sad		656			
United Kingdom	IGER, Aberystwyth		1	4	15	11
	RBG, Haywards Heath	1	8		9	

Buckwheat

Common buckwheat *(Fagopyrum esculentum* Moench.)
Tartary buckwheat (*Fagopyrum tataricum* Gilib.)

Introduction

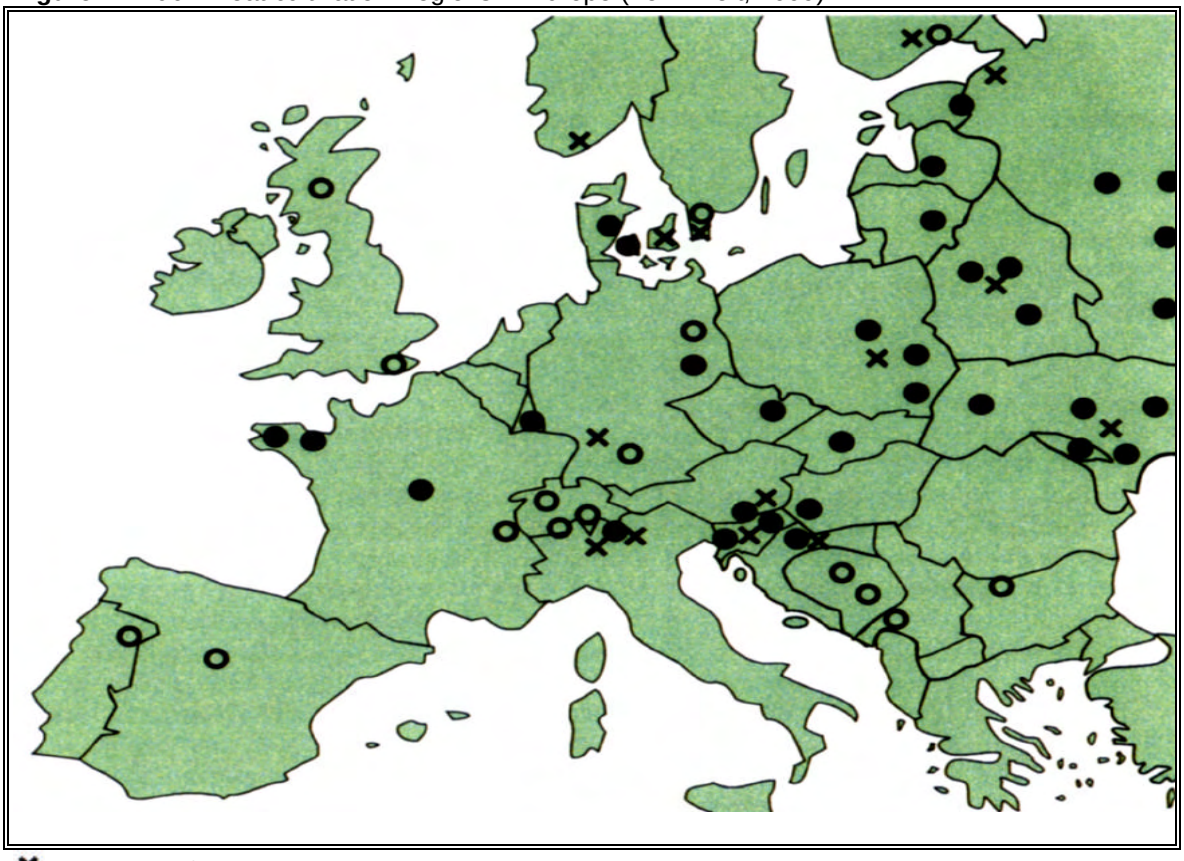
These crops are not cereals, but the seeds are usually classified among the cereal grains because of their similar usage. The grains are generally used as human food and as animal and poultry feed. The dehulled groats are cooked as porridge and the flour used in the preparation of pancakes, biscuits and noodles. In Europe, buckwheat noodles are known in Slovenia, in northern Italy and in southeastern France. French salted buckwheat pancakes '*galettes*' are served with butter, eggs, ham or other fillings. Buckwheat bread made from roughly 30% buckwheat flour and 70% wheat flour is popular in Slovenia. Buckwheat groats (dehusked buckwheat grains) also known as '*kasha*' (Kreft 1997) are very popular in some countries of Central and Eastern Europe (former Czechoslovakia, Poland, Russia, the Ukraine, etc.). Buckwheat beer is made in Belgium.

Buckwheat distribution and seed production in Europe

It is possible that buckwheat was introduced to Europe from southwest China via northern China and Siberia, and from there probably over Russia and the Ukraine to central Europe where it appeared around the year 1400. From Central Europe buckwheat spread further to western Europe.

In Europe, buckwheat is grown mainly in Austria, Belarus, northern Croatia, Denmark, northwestern France, Poland, Russia, Slovenia and the Ukraine (Table 6). In the first half of this century, buckwheat spread mainly to the Czech Republic, Germany and Slovakia and, to a lesser extent, to Bosnia-Herzegovina, Bulgaria, Finland, Great Britain, Portugal, Spain and Switzerland, but was later replaced by other crops. To a lesser extent it is grown in Hungary and it is being grown once again in the Czech Republic, Luxembourg, northern Italy and Slovakia. Buckwheat production also commenced in Norway as a raw material for dietetic foods (Figure 1).

Figure 1. Buckwheat cultivation Regions in Europe (from Kreft, 1999)



× Regions of cultivation and research centres on buckwheat

● Regions of contemporary buckwheat cultivation

○ Regions where buckwheat was cultivated in the past but no further information is available

At present, the demand for buckwheat is due to its excellent properties and nutritional value based on the favorable composition of protein complex with a high content of lysine, fibrous material, mineral compounds, vitamins and bioflavonoid rutin (Keli 1992; Michalová *et al.* 1998). From a health point of view buckwheat is also an important gluten-free crop.

Buckwheat is a low input plant (Kreft & Luthar 1990), making it very suitable for organic farming. In 1994 the production of organic buckwheat in the Czech Republic was 108 t. By 1997 it had increased by more than 200 % (Hutar 1997). In 1999 production was 520 t of organic and about 1500 t of conventional buckwheat (Table 5). There are over 30 different buckwheat products available on the Czech market.

Table 6. Buckwheat production and cultivated area in Europe

Country	Production (t)	Cultivated area (ha)	% total cropped area
Russian Federation	875007	1764770	3.06
Ukraine	424356	473333	3.78
Poland	47425	46249	0.55
France	21659	8501	0.09
Belarus	10000	26333	1.02
Czech Republic	2020	1800	0.07
- organic	520	500	0.02
- conventional	1500	1100	0.04
Slovenia	567	553	0.47
Lithuania	200	600	0.05
Estonia	167	100	0.03
Yugoslavia, F.R.	152	112	
Croatia	30	50	0.01

Ex situ conservation

The buckwheat collections in European genebanks are shown in Table 7. The N.I. Vavilov Research Institute of Plant Industry collection is the only large collection that has attempted to obtain representation from many parts of the world. The Ukraine is a very important growing and research buckwheat centre. The total number of accessions given by the Ukraine probably includes many developed mutant forms of buckwheat.

Table 7. List of European Institutions holding buckwheat GR – open information

		Number of accessions		
Country	**Institute**	***Fagopyrum esculentum***	***Fagopyrum tataricum***	***Fagopyrum* spp.**
Austria	Federal Office of Agrobiology, Linz	9 L		
Czech Republic	RICP, Prague	120	16	
France	INRA, Le Rheu	10 L 20 AC 90 GS	80 GS	
Germany	FRCA, Braunschweig	73 L 24 AC	4 L 4 AC	12 L 1 AC
	IPK, Gatersleben	84	13	6
	Botanic. Garden, Postdam			1
	University of Kassel, Witzenhausen	1		
Hungary	Institute for Agrobotany, Tapioszele			92

Latvia	State Agricultural Research Inst., Skriveri	70		
Poland	Institute of Medicinal Plants, Poznan	1		
	PBAI, Radzikow	15		
		41 AC		
		18 BIL		
Romania	Genebank of Sucaeva	2 L		
		1 AC		
Russia	N.I. Vavilov RIPI, St.Petersburg	2157	100	2
Slovakia	RICP, Piestany		8	
Slovenia	Agronomy Dept. Univ. of Ljubljana	361	17	
Spain	INIT, Madrid	2 L		
Switzerland	PRO SPECIE RARA, St. Gallen	2		
Sweden	NGB, Alnarp	4 L		
Ukraine	UES, Ustimovka		1405	

L = landraces, **AC** = advanced cultivars, **GS** = genetic stock, **BIL** = breeding or inbred lines, **U =** unknown

There is insufficient information about the rest of Europe. Buckwheat germplasm collecting has so far been inadequate. A large area of southern Europe has few, if any, collections presently in storage. Accessions originated in Italy are present in the Slovenian collection, while no buckwheat collection exists in Italy.

A similar situation existed in the Czech Republic. At the Research Institute of Crop Production in Prague Ruzyne, there was no buckwheat collection until 1993. At present, common and tartary buckwheat collections involve 136 accessions, most of which were obtained from foreign genebanks. Some of them have been selected for more detailed studies. Domestic material presents a small part of the collection. Now we are searching all available world buckwheat collections for the presence of former Czechoslovakian material. We found that four Czechoslovakian buckwheat accessions which were presumed lost, are maintained in National Seed Storage Laboratory (NSSL) at Fort Collins, Colorado, USA. As for other European buckwheat genotypes, the GRIN-WWW Service (Database Management Unit of the National Germplasm Resources Laboratory, Plant Sciences Institute at Beltsville, Maryland, USA) includes two accessions from Italy, one from Denmark and two from Sweden although the Nordic Gene Bank database maintains only Finnish materials.

Another problem is the lack of basic passport data for many accessions of buckwheat in Europe.

In situ conservation

In Europe, buckwheat is also grown in organic farming systems. Information about *in situ* conservation has not yet been completed. Only Georgia presents three buckwheat genotypes conserved *in situ* (Nemsadze 1999). On-farm conservation of selected domestic genotypes is planned to commence in 2001 in the Czech Republic.

Tartary buckwheat

Attention should be given to tartary buckwheat whose seeds have a significantly higher rutin content than common buckwheat. Green matter content is comparable. Bitter buckwheat or tartary buckwheat (*Fagopyrum tataricum*) is sometimes called 'green buckwheat' because of its yellow green flowers, brown-green grains and bitter greenish flour. It is mainly grown in some areas of China, Bhutan and Nepal and some parts of Europe. In the last few years, there has been a demand for bitter buckwheat, mainly as a medicinal plant, because of its high content of rutin and other polyphenols.

Bitter buckwheat is much more resistant than common buckwheat to frost and other unfavourable climatic and weather conditions, and to poor soil conditions. Bitter buckwheat is also better resistant to grazing by wild or domestic animals. Seeds of bitter buckwheat are shed more than seeds of common buckwheat. Sometimes it is

difficult to collect all seeds at harvest time. Bitter buckwheat seeds resist better in the soil than seeds of common buckwheat. There is still a chance for collecting. A sample of tartary buckwheat, which was found in 1996 in Moravia, was included in the Czech buckwheat collection.

Some bitter buckwheat products of are available in Germany.

Conclusion

The European region is home to a great variety of underutilized cereals, which should be used for diversifying European agriculture and food. Economically more important crops replaced many traditional varieties and landraces of minor crops. Many of these are preserved in genebanks but many were also lost.

Another problem is a lack of basic passport data for many of the accessions maintained. Duplication of accessions needs to be identified and information about minor cereals needs to be presented in a database format.

Most collections of small cereals are old and need to be collected again.

It is important to promote regional activities, on-farm conservation and utilization of genetic diversity of minor cereals and collaboration with the private sector.

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Appendix I. Concluding remarks of a Meeting of the ECP/GR Minor Crops Network Coordinating Group

Hotel Marina Palace, Turku, Finland, 16 June 1999

Prepared by Lorenzo Maggioni, ECP/GR Coordinator

Participants

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Scope of the Network

Discussion on the scope of the Minor Crops Network focused on the definition of "Minor Crops " and the criteria that should be used to identify priorities for action.

M. Hulden explained the Nordic Gene Bank example, where candidate species to be considered Minor crops belong to the following categories:

- Underutilized traditional crops;
- Spices and medicinal plants;
- Plants for environmental remediation and for biofuel production;
- Potential new crops;
- Ornamental plants.

F. Grassi and M. Mitteau presented a different level of definition of minor crops, based on commercial value, rather than on typology of use:

- ?Minor crops have a limited production and consumption.?
- Minor crops are often limited to specific areas where both ecological and market niches exist, including the industrial process.
- ?Minor crops have a strong local identity linked to social and cultural values. They are closely linked to traditional knowledge and to specific know-how.
- ?Minor crops may be value added by direct and local commercial distribution, since they meet the requirements for being granted the "quality product label".
- ?Genetic resources of minor crops are often connected with different stakeholders including NGOs and local conservatories.
- ?Genetic resources of minor crops are more fragile, subject to genetic erosion and are often rather difficult to localize.

The Group agreed that the Minor Crops Network would extend its scope to include the genetic resources of crops identified by both sets of the above mentioned definitions. It would also include the category "Neglected and underutilized species", as defined in FAO 1996 and in the Global Plan of Action as "indigenous species with potential to contribute to agriculture and diet diversification". However, a discussion followed on the opportunity to include ornamental plants within the scope of the Minor Crops

Network. A. Della reminded the Group that there is a tendency to use ornamentals from the wild flora for landscape purposes and that some ornamental species play a role in ecosystem conservation. Overall the Group thought that in the initial stage of development of the Minor Crops Network, it would be preferable to exclude this typology and concentrate primarily on food and agriculture crops. However, the possibility of including ornamentals within the scope of the Network could be reconsidered at a later stage.

To select priority species for action, the Group would refer to the following agreed criteria:

1. Risk of genetic erosion.
2. Economic importance.
3. Regional or sub-regional distribution.
4. Traditional knowledge in Europe.
5. Indigenous origin.
6. The use of the crop.
7. The present use of the genetic resources (plant breeding or other research).
8. The level of available genetic diversity.

The Group agreed on a proposal from Fabrizio Grassi and Martine Mitteau that the Minor Crops Network could be presented as a horizontal structure within the overall operational structure of ECP/GR. This would enable the clear connection between this Network and all the other Crop Networks. Linkages between the Minor Crops and each of the other Crop Networks would become the responsibility of a focal person representing different typologies of minor crops.

Workplan

The Group identified, from within its members, two focal points for "minor fruits" and "minor cereals" (see Table 1). For the remaining typologies, focal persons are yet to be identified. The Coordinating Group, as well as the National Coordinators, are welcome to send suggestions to the ECP/GR Coordinator.

Table 1. Focal points for "Minor Fruits" and "Minor Cereals"

Minor crop typology	Focal person
Cereals	Anna Michalová (Czech Republic)
Fruits	Ignacio Batlle (Spain)
Industrial crops	*To be identified*
Legumes	*To be identified*
Vegetables	*To be identified*

The Group agreed to assign the focal persons the coordination of the following two actions:

Action 1: The focal points, in coordination with the respective "major crops" NCGs, will identify a list of crops/species which should become the focus of the Minor Crops Network activity. One or two crops/species from this list would be chosen for priority action. Selected crops should belong to different geographical areas, resulting in well balanced representation of different regional interests. (Action to be completed by December 1999).

Action 2: Once the priority crops/species are selected, focal points will start collating existing information related to genetic resources conservation and use. In this process the focal point is expected to work in collaboration with experts from different parts of Europe and to complement ongoing work carried out in other related Networks. The objective of this action is to compile information about:

- *Ex situ* and *in situ* conservation status

- Distribution and level of utilization
- List of experts / institutions
- List of ongoing activities
- Elaboration of a conservation strategy to be proposed for further action

(Action to be completed by December 2001)

It is expected that the result of the above analysis will be presented at the next Minor Crops Network meeting and the proceedings will be published by IPGRI.

Medicinal and Aromatic Plants

Dea Baričevič's presentation emphasized the ongoing work at her institute for medicinal and aromatic plant genetic resources. She highlighted that the most urgent needs for safeguarding European Medicinal and Aromatic Plants (MAP) genetic resources are the establishment of a regional inventory of existing resources and their conservation status. Agreed descriptors for characterization, based on the use of the plants, are generally missing. Strategies for *ex situ* and *in situ* conservation need to be defined. Utilization through introduction into cultivation is often considered an effective conservation strategy. The Group agreed on the growing importance of MAP for sustainable agriculture in Europe, and that the fair and equitable utilization of these European genetic resources depends on the collaborative work of inventorying and evaluation. The Group was aware that the issue of involving ECP / GR with MAP had been taken into consideration by the ECP / GR Technical Consultative Committee (First meeting, Nyon, Switzerland, 1983). At that time, lack of proof of genetic erosion was considered a decisive element in deciding that the establishment of a Working Group was not a priority. The danger of genetic erosion may have changed in the last 16 years. Moreover, the Group believed that the usefulness of a Working Group on MAP would have a broader role than the simple defense of endangered genetic material, and that it could contribute to a more effective and sustainable use of these species. Attention to MAP within ECP / GR was thought to be a relevant step contributing to the implementation of the Global Plan of Action (Leipzig, 1997) and the Convention of Biodiversity (Rio, 1992).

The Group agreed that the establishment of a Working Group on Medicinal and Aromatic plants (Officinal plants) should be proposed for the attention of the Steering Committee at the Phase VI Mid-term meeting. Dea Baričevič, in collaboration with Karl Hammer, would be responsible for developing a proposal for collaborative action, to be implemented in the context of a new Working Group. She was also invited to contact colleagues working in the field of MAP genetic resources in Europe who would be available to participate in collaborative work. ECP / GR country coordinators were invited to suggest national MAP reference persons whom they considered appropriate to the ECP / GR Coordinator. The proposal of D. Baričevič and K. Hammer will be circulated to the Network Coordinating Group and the ECP / GR Coordinator by the end of March 2000, with the aim of finalising it and presenting it to the Steering Committee by the end of June 2000. It was later suggested that close consultation be maintained with Uwe Schippman of the IUCN medicinal plants specialist group (and with Wendy Strahm, Plants Officer, IUCN).

Search catalogue

The Group welcomed the Nordic Gene Bank offer to compile a list of species held in European genebanks, including the respective number of accessions conserved. Information ought to be collected at the species (not genus) level and include material conserved in field collections as well as *in situ* (whenever a specific conservation management plan exists). The Group agreed that a simple questionnaire ought to be sent

by the NGB to the National Coordinators, who would be asked to gather this information within their countries and forward it to the NGB. This exercise has the main objective of establishing an initial knowledge base on the conservation status of minor crops in Europe. However, it is considered easier to request information on all crops, rather than assigning database managers the laborious task of extracting specific minor crops' data from the whole body of available data.

Red list of European cultivated plants

K. Hammer mentioned his ongoing work for the development of a list of European cultivated plants, which already includes about 350 minor crop species from middle Europe. He stressed that most of them are not well represented in genebanks and that it would be useful to improve the knowledge on the existence of minor cultivated plants in Europe. While reasonable knowledge exists for southern Italy, thanks to the work of Pietro Perrino, little knowledge is still available for other European regions, such as the East and the Mediterranean area. K. Hammer specified that his work is not focussing on wild plants, but on plants that went through some selection process and are maintained under cultivation, although often in small niches and for local use. He said that the remaining landraces should be collected as far as possible and preserved in the genebanks, since it is not always feasible to ensure their conservation *in situ*. K. Hammer mentioned his intention to contribute to the compilation of a Red Data Book for European crop plants.

Appendix II. List of Participants

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