Lathyrus Genetic Resources Network

Proceedings of a IPGRI-ICARDA-ICAR Regional Working Group Meeting

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International Plant Genetic Resources Institute
IPGRI

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Contents

Foreword

A relatively small number of crops are used to produce the bulk of the world's food, fibre, and other industrial products. A much larger number of crops are used by local people for specific purposes, or important only in certain ecosystems. Such crops termed neglected or underutilized, possess a great range of genetic diversity and may hold potential both for improving the livelihood for local people where such crops are adapted, and for improving the diversity, productivity and sustainability of agricultural systems. Neglected and underutilized crops' have received relatively less attention in national or international priorities. IPGRI has recognized the potential importance of such crops, and in partnership with others around the world, has undertaken a series of activities to understand and promote the role of such crops in helping to achieve food security and agricultural sustainability through local peoples' maintenance of diversity and in realizing their potential for improvement. In Asia, the Pacific and Oceania region, IPGRI has given priority to work on a limited number of such crops including safflower, sesame, buckwheat, *Lathyrus*, taro, minor millets and minor legumes. As a result, a number of networks have been initiated to effectively conserve and utilize the diversity of these crops.

The potential of *Lathyrus sativus* (Grass pea) as a nutritious pulse with high quality grain and fodder, is well recognized in South Asia, Ethiopia and parts of Central, West and North Asia, where other species of this genepool also occur. The local types are tolerant to flood and drought conditions and possess unique adaptation as a post-rice crop across much of South Asia. Other cultivated species of *Lathyrus* are *L. ochrus* and *L. cicera* mainly grown in Central, West and North Africa as a fodder crop.

Interest in South Asia – India, Bangladesh and Nepal has been primarily to develop low neurotoxin level types in grass pea possessing high yield so that these can be grown as a pulse. In West Asia, there is interest to develop improved *Lathyrus* lines as a fodder legume. These countries thus through concerted national efforts and collaboration with international organizations including IDRC, in Canada; ICARDA, in Syria; and CLIMA, in Australia have been able to produce varieties and develop a research programme directed towards improvement of grass pea. IPGRI has assisted to catalyse these activities by bringing such countries together to share their experiences and also develop a concern on a collaborative approach through a regional network based on *Lathyrus* genetic resources conservation and use. In 1995, IPGRI and Indira Gandhi Agriculture University organized a *Lathyrus* genetic resources workshop in Raipur (India) wherein the participating countries (Bangladesh, India, Nepal from South Asia; Jordan and Turkey from Central and West Asia; and international organizations including ICARDA, IPGRI, CLIMA and ICRISAT) recommended that a Lathyrus Genetic Resources Network should be considered. In this workshop, the status of *Lathyrus* genetic resources was reviewed and a working group was proposed to follow-up on the suggested network activities.

These proceedings are the outcome of the first meeting of this Working Group. This meeting, which took place at NBPGR, New Delhi in December 1997, reviewed progress, reaffirmed the concern and interest of the participating countries in this crop and worked out on the modalities of the Lathyrus Genetic Resources Network (LGRN) – its proposed structure and functioning. It also reviewed the status of genetic resources activities since the last meeting. These proceedings thus deal with the *Lathyrus* genetic resources and improvement activities being carried out by different national programmes and the recommendations that emerged from the three day deliberations of the Working Group.

Several activities have already been taken up as part of an important network.

The strengthening and support for priority research and development activities in such low cost, informal networks, can be an effective mechanism for the promotion of neglected and underutilized crops such as *Lathyrus*. It is felt that the establishment of a Lathyrus Genetic Resources Network as proposed will help further promote and strengthen and sustain activities on conservation and use of *Lathyrus* genepool. As a follow up of the recommendations of this workshop, IPGRI will soon be publishing a *Lathyrus* Directory, and also the Descriptor List for the use of participating scientists and other interested partners.

We would like to thank Drs. V. Ramanatha Rao, R. K. Arora and P.N. Mathur for their efforts to organize this workshop and produce these proceedings, and Dr. Stefano Padulosi for providing needful assistance during the workshop.

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Preface

In South and West Asia, IPGRI has been promoting several activities on genetic resources of underutilized crops important to Asia, namely buckwheat, safflower, *Lathyrus*, sesame, taro, minor millets, and minor legumes. In most cases, the emphasis has been on the development of low transaction cost networks to promote collaboration in the region. To prioritize and organize activities on *Lathyrus* improvement, conservation and utilization in a network mode, a regional workshop was organized jointly by IPGRI and ICAR in December 1995 at the Indira Gandhi Agricultural University, Raipur. This meeting was important in many ways. It helped to develop a Lathyrus Genetic Resources Network (LGRN) based on an assessment of the status of genetic resources of *Lathyrus* in the region and to prioritize and organise collaborative activities by various participating national programmes.

The proceedings of the 1995 workshop were widely circulated and the IPGRI South Asia office coordinated several activities that were carried out within the frame work of an informal network. IPGRI helped to keep links with participating countries and international organizations and other countries/concerned partners, to develop information base needed to produce a Directory on *Lathyrus* and in developing a descriptor list for *Lathyrus*. *Lathyrus* improvement by using low ODAP lines was emphasized for producing high nutritional grain quality grass pea particularly in Bangladesh, India and Nepal. The value of cultivated and wild genepool of *Lathyrus* to facilitate its exploitation as both grain and fodder crop was emphasized. Research on *L. ochrus* and *L. cicera*, two other cultivated species was undertaken at ICARDA.

As a follow up on the recommendations of the Raipur Workshop, a Working Group meeting was organized by IPGRI at NBPGR, New Delhi during December 1997. At this meeting, the progress on *Lathyrus* genetic resources activities since the Raipur workshop was presented (the proceedings include 13 papers on different aspects). At this meeting, it was possible to re-ascertain the interest of the national programmes and international organizations in this neglected crop, as well as the interest of the countries/partners to work within a network on *Lathyrus*. The need to somewhat formalise the network was recognised and agreed. The network was named Lathyrus Genetic Resources Network (LGRN) and its structure and functioning worked out. The future programme was also discussed and recommendations finalized. The envisaged network would span two IPGRI Regions i.e. South Asia and CWANA and represents an example of strengthened international collaboration through Crop Networks. WANANET, a network implemented by IPGRI-CWANA has already identified *Lathyrus* as a regional priority.

The Coordinator, IPGRI South Asia Office will be the focal point for this network and provide the interim Secretariat to the network. Among these activities, at present, priority is assigned to the publication of a Directory on *Lathyrus*, and a Descriptors list. Both are considered important in dissemination of information for use of partners. It was agreed that the LGRN will promote conservation and enhancement of *Lathyrus* genetic resources for increased production and facilitate germplasm exchange between member countries as per their national policies, and promotes utilization through development of promising cultivars with improved adaptation and nutritional qualities. Research thrust will be through five Working Groups, namely Genetic Diversity, Germplasm Enhancement and Use, Nutritional Quality, Information Management and Training, and Socioeconomics. The focal species of LGRN will be *L. sativus, L. cicera,* and *L. ochrus.*

While some work has been taken up by IPGRI-APO within its project on underutilized crops, other activities such as on establishing international nurseries, toxicological and biotechnological work and participatory breeding and on-farm conservation, emphasis on *Lathyrus* as a fodder crop will follow soon. Efforts to mobilise resources needed to carry out the proposed activities and to develop LGRN into a sustainable entity were endorsed by the participants and all countries agreed to support the development of a proposal by IPGRI for submission to a suitable donor. It was also suggested by participants that in the year 2000, a larger global conference on *Lathyrus* genetic resources may be organized in Dhaka, Bangladesh, to have much wider participation.

We are confident that these proceedings will generate more interest in Research & Development of *Lathyrus* genetic resources, and promote further the conservation and utilization of this underutilized but important genepool in *Lathyrus* growing areas of Asia and Africa in particular.

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Summary and Conclusions

During the Regional Working Group Meeting on *Lathryus* Genetic Resources Network, the participants agreed to establish the network formally. The group discussed the name, scope of the network, objectives, membership, etc., and the following decisions were taken:

Name
Lathyrus Genetic Resources Network (LGRN)

Scope
The major emphasis will be on *L. sativus*, with some attention given to the two other most important species, viz., *L. cicera* and *L. ochrus*. The rest of the species will be included for the purpose of documentation and for use in other activities including genetic diversity studies/resistance breeding etc.

Objective
Conservation and enhancement of *Lathyrus* genetic resources for increased production and promotion of germplasm exchange between member countries per their national policies and priorities and utilization by developing cultivars with improved adaptation and nutritional qualities.

Membership
Membership is open to all countries with interest in *Lathyrus* genetic resources conservation and/or use and includes people from different discipline and backgrounds including biotechnologists, medical, etc., and from formal and informal sectors.

Structure
The following is a tentative structure agreed and details will have to be filled in later on when actual network gets organised:

Secretariat – IPGRI South Asia Office, New Delhi, India
Coordinator – Dr. R.K. Arora (Interim)

Country Coordinators:

Bangladesh	Dr. M.A. Malek
India	Dr. A.N. Asthana
Nepal	Grain Legume Coordinator, presently Dr. M. Joshi
Australia	CLIMA
Pakistan	IPGRI-CWANA – to follow up
Ethiopia	ICARDA to follow up
Jordan etc.	A representative from WANA-NET (Pasture/forages working group member). IPGRI-CWANA to follow up
China	IPGRI-SA to follow up (proposed: Dr Yu Jing-Zhong, Associate Professor at The Soil and Fertilizer Institute, Academy of Agricultural Sciences, Yangling, Shaanxi 712 100, P.R. of China)
Canada	IPGRI-SA to follow up (proposed Dr Clayton Campbell, Kade Research Ltd., 135 13th street, Morden, Manitoba, Canada R6M 1E9)
Italy, Spain, Poland, U.K., Belgium, etc.	Contact persons to be identified through ECPGR of IPGRI-Europe Group; IPGRI-CWANA to follow up

ICARDA	Dr. Larry Robertson
IPGRI-CWANA	Dr. S. Padulosi

The following international organizations whose support is to be sought may be invited to participate in LGRN meetings:

EC Office, Brussels/EU; FAO; ICRISAT; ACIAR; IDRC; IFAD.

Steering Committee (SC)

Steering Committee is the planning body for the network and shall consist of all country coordinators and representatives for same regions/organizations and the Coordinator. Additionally, when need arises, specialists may be co-opted to enhance the effectiveness of Steering Committee.

Steering Committee will have a Chairperson (a member country) as determined by the SC members. Selection of the Chairperson will be by consensus and on rotation basis.

Working Groups (WG)

Theme-based Woking Groups (WGs) shall provide focus to the LGRN. Thematic WGs are not representational, but will consist of experts from different discipline. These are:

WG1 Genetic Diversity
WG2 Germplasm Enhancement and Use
WG3 Nutritional Quality (including Chemistry, Biochemistry and Biotechnology)
WG4 Information Management and Training
WG5 Socioeconomics

Country coordinators, in consultation with the concerned authorities and *Lathyrus* researchers in their respective countries, will identify the members for different WGs. WG Chairperson(s) will be determined by the members of each WG. When there is no Country Coordinator in a WG, then the Chair of that WG will also be SC member.

Activities under LGRN

The group discussed at length various activities that can be undertaken by LGRN and funding needs. There are activities that are either already ongoing or planned by certain organisations, but could be considered as activities by the Network as the results would be applicable in general. Such activities do not need to wait for additional funds to become available. On the other hand, there are activities that will require sourcing of funds. These could be included in any proposal that may be developed or funds could be sourced separately. On this basis, the Group agreed on the follow-up given hereunder.

LGRN activities between now and the time when funds become available

1. Lathyrus database

These are either low cost or no cost activities, some of which are being carried out by IPGRI-South Asia office. Dr. P.N. Mathur will continue to coordinate information and documentation activities for LGRN and will continue to work on *Lathyrus* Germplasm Directory, *Lathyrus* Workers Directory etc. ICARDA will provide information from WANA and Ethiopia. Other countries could provide this directly to Dr. Mathur.

Considering the need for some level of standardisation for developing the *Lathyrus* database, priority was accorded for developing descriptors. A small group to work on the development of the descriptors was identified, consisting of the following:

IGAU, Raipur, India (Dr. R.L. Pandey)
NBPGR, New Delhi, India (to nominate)
IPGRI-South Asia Office, New Delhi, India (Dr. P.N. Mathur)

ICARDA, Aleppo, Syria (Dr. Larry Robertson)

The descriptors will focus mainly on *L. sativus*, *L. cicera* and *L. ochrus* (focal species of LGRN). Dr. R. L. Pandey will take the lead to develop first draft of the list by 1 May 1998.

2. Development of a proposal and sourcing for funds

The Group discussed the need for developing a comprehensive proposal on the activities that could be carried out with LGRN. The Group agreed that:

- IPGRI-APO to continue developing the proposal with inputs from all the members.
- there may be need for the meeting of Network-members, even before any external funds could be sourced and need to explore possibilities of meeting of LGRN members within 2 years, in the absence of any external funding.
- ICARDA may be able to help the participation of a representative from Ethiopia.
- WANA–NET may help the participation of the members from WANA-NET
- IPGRI to explore possibilities for other members, while the country coordinators will also look for their own resources.

The group noted that most of the relevant background material is available in the draft prepared by IPGRI. Additional information and comments will have to be provided by the members. So the Group urged all the members provide additional information as well comments to IPGRI-APO within one month i.e. before the end of January 1998. Dr. R.K. Arora will also send request for the same.

Information will also be needed on currently funded *Lathyrus* work/projects in different countries and different agencies. These funds may be shown as co-financing in the proposal. The Group recommended that each national programme to indicate the amount spent on *Lathyrus* research and development that could be shown in the proposal as budget from the participating countries.

The Group suggested that the funding request should include the following:

- Network meetings
- Newsletter
- Assistance to Secretariat
- WG meetings
- Funds for key research and development activities

3. Proposed research activities

Various reviews presented at the meeting as well as the discussions that followed the presentations helped in clarifying several issues related to *Lathyrus* genetic resources conservation and use. Based on this information, the group recommended that the following activities be included in any proposal that will be developed:

A. Development of database based on descriptor list: This activity will link with the current ongoing activities on *Lathyrus* information management. The Group urged country coordinators to send the information to Dr P.N. Mathur, who will coordinate the information and documentation activities, to put it into the Central Database on *Lathyrus* Genetic Resources. Analysis of this database will help in the rationalization of the collections.

B. International Nurseries: It was agreed to have three international nurseries:

1. Low ODAP content accessions, and lines with improved nutritional qualities,
2. High yield and high biomass lines, and
3. Disease nurseries.

ICARDA is already organizing some international nurseries for *Lathyrus*, hence the Group urged ICARDA to develop the above proposed nurseries for LGRN. Dr. Larry Robertson will follow up with appropriate people in ICARDA to promote this activity which can start right away and does not need much funding. Seed needs to be multiplied first at ICARDA to facilitate quarantine needs and dispatch of seeds from one location. The suggested time frame is given below:

- 1998 - 99 - Seed Multiplication
- 1998 - 99 - Nursery with material at ICARDA
- 1999 - 2000 - First full international nursery

The Group felt that the analysis of ODAP could be done in different institutes e.g., CLIMA (Australia), Raipur (India), Ghent (Belgium). There will be some need for upgrading the facilities for ODAP analysis and training in the use of the analysis technique. Genotype x environment variation in ODAP content can also be built into this activity, which is an important area to look into.

This activity will also focus on breeding for high yield (including forage yield) and low ODAP content lines. ICARDA is already doing some breeding work and early generation material may be supplied for testing in key countries. The hybrids needs to be developed with locally adapted parents.

C. Toxicological work: In the study of the mode of action of the *Lathyrus* neurotoxin, there are following major limitations:

- Since the epidemic of 1972-74, only a few cases have occurred in Bangladesh and Ethiopia.
- An animal model for lathyrism does not yet exist (A medical group in Ethiopia, organised by Dr Redda Tekle Haimanot, is working on the development of an animal model, using goat and horse).
- The agro-economic conditions that preceded the historical epidemics can not the reproduced and the seed that was consumed at that time is no longer available.
- The individual variation in the susceptibility is as yet unexplained, suggested precipitating factors include: zinc deficiency, under-nourishment and environmental effects on the level of neurotoxin in the plant.

A recent outbreak of human lathyrism is now reported in Ethiopia (Monitor, 6 November 1997, Addis Ababa). This offers a sad but unexpected opportunity to examine both the plant, whose seeds might have caused the disease, and the patients who recently developed lathyrism. Analysis of the level of toxin and other secondary compounds in the plant should indicate whether there is a critical difference in composition. Analysis of the nutritional status of patients, including amino acid profile in serum and urine, micronutrient status (Zn, Mn, Fe etc.), vitamins etc., should indicate whether nutrition deficiencies may be responsible for the sudden increase in susceptibility to this permanently crippling disease.

The Group strongly felt that an urgent survey of the foods consumed in the affected region of North and South Wollo zones, chemical analyses in specialised laboratories must be done. Medical examination of representative patients, preservation of serum and urine samples, and eventually tests are also required. Local medical doctors who recently were involved in the epidemiological survey of the regions (directed by Dr. Redda Tekle Haimanot) should be carrying out these. The analysis of freeze dried samples may be carried out in specialised laboratories in Europe (London or Ghent).

Identification of the deficiency that can enhance the susceptibility to the *Lathyrus* neurotoxin may lift the stigma on the consumption of *Lathyrus* seeds, which under all conditions is the cheapest source of protein available to people in the Indian subcontinent and Ethiopia and the neighbouring African countries.

This work can well link with the EC project as well as Nile project in Ethiopia. ICARDA Nile Valley Project will be contacted and a survey of lathyrism epidemic will be suggested. Dr. Fernand Lambein will supply the names of the contact persons for this work. Dr. Lambein has some funds and he will look into the possibilities for using some of these funds for this work. ICARDA Anthropologist will be contacted to be involved in this work by Dr. Robertson.

D. Lathyrus Genetic Resources Conference: The Group agreed that an International Conference be held about two years after the present meeting in New Delhi, to bring together all researchers actively involved in *Lathyrus*/lathyrism research. The Group suggested that such a conference be held in 2nd week of January 2000 in Dhaka, Bangladesh. (Dr Dan Cohn in Tel Aviv, Israel, a neurologist following the victims of lathyrism from a WW II labour camp, plans to organise a meeting two years from now covering various aspects of *Lathyrus*/ lathyrism. The proposed conference could benefit from organising it back to back with the former). The Group also agreed on the following:

Objective of the Conference: Review of the progress in producing and utilization of *Lathyrus* cultivars with better nutritional quality for food and feed. Also to review the progress made in other network activities.

Participation: All *Lathyrus* research and development workers may be invited to participate. The Network, Steering Committee and the Working Group meetings could be held at the same time. Also, this time can be used to review the progress made by the Network and to plan for the immediate future. Depending upon the participation some or all the Working Groups will also have an opportunity to discuss and develop new/modified thematic activities.

E. Publication of Working Group Proceedings: It was agreed that the Proceedings of the current workshop will be published and distributed by the IPGRI Office for South Asia, New Delhi, with editing of presentations as needed.

LGRN activities that will need funding to start

A. Pilot Project on farmers' participatory breeding and on-farm conservation

The Group agreed that, considering the status of *Lathyrus* cultivation, participatory methods of its improvement will be highly relevant. Adapted material can be given to farmers allowing farmers to make selections for local adaptation. The adapted material can come from segregating populations (F_3 and advanced lines) of crosses made using locally adapted material. Rapid Rural Appraisal (RRA) methods have to be used for the identification of farmers, preferences and incorporate their needs into the programme. Nutritional quality of the material on-farm could be included. Farmers' preferences for dual purpose (food and fodder) can be usefully included in such an effort. Additionally, there is a scope for socioeconomic studies.

Although there are other legumes that can be grown, most of such legume crops will require additional irrigation while *Lathyrus* does not need irrigation, hence it will be a big advantage from the point of environmental health as well as sustainability. Additionally, *Lathyrus* is a superior fixer of nitrogen and thus helps in improving the soil fertility status. This also results in the reduction of nitrogen fertilizer, production of which is harmful for the environment.

B. Lathyrus as a fodder crop

The Group agreed that the emphasis on *Lathyrus* as a fodder will have to be increased and for this another set of parameters for the development of dual purpose *Lathyrus* cultivars should be used. This should include traits related to quality in terms of animal feeds (seed, straw and hay palatability etc.). It will need to include comparative studies with other legume crops for fodder. Analyses at different growth stages using different plant parts will have to be made. Example: chickpea and lentils are not preferred as forages. In WANA region lentil straw may be preferred. The quality of biomass would be greater in the case of *Lathyrus*. Nitrogen fixation and use in marginal lands will be additional advantages of using *Lathyrus* as a fodder crop. Rhizobial strains with higher nodulation frequency are also available which can be used for *Lathyrus*. Some of the animal research institutes can also be involved in this testing. There are areas where *Lathyrus* is only grown as fodder. International Livestock Research Institute (ILRI) has some germplasm from ICARDA but ILRI itself is not doing any work on *Lathryus*. CLIMA has plans to review the animal uses of *Lathyrus* and also is planning to develop animal tests using pigs for *Lathyrus* quality. Animal testing is presently going on in Poland, which were reported at a recent symposium in Radom, 9-10 June 1997, contact person: Prof. E. Grela (Emal: ergrela@ursus.ar.lublin.pl). Work has also been done in Canada from the animal nutrition viewpoint, and in Ethiopia on goat and horse from the medical and neuropathological viewpoint.

C. Sustainability issues
Lathyrus has great sustainability value for use in marginal areas and as a cover crop. It is known that *Lathyrus* sustainability value is about 50% in a farming system. This needs further investigation to promote *Lathyrus* cultivation and production. A study could be designed to investigate the sustainability value of *Lathyrus* which will not only help with respect to public awareness, but also in identifying the appropriate and non-traditional areas for its cultivation.

D. Training
Need for training in analysing toxin content was recognized by the Group. Countries like Nepal do not have any facility at this point of time. It may be better for such countries to focus on training in germplasm conservation and enhancement. However, the countries may need at least minimum facilities to monitor ODAP content. LGRN has to develop human resource development (HRD) activities that will focus on the various aspects of *Lathryus* research as well as conservation of its genetic resources. The Group urged countries to coordinate these activities with international and regional organisations like CLIMA, ICARDA and IPGRI (Training in biotechnology is also possible in Ghent, Belgium).

E. Developing *ex situ* conservation technologies
Though *Lathyrus* produces orthodox seeds considering hard seededness, some research into conservation of seeds for long-term (-20°C and cryopreservation) will be needed. Additionally, one could look at conservation of pollen. Considering the high stress environment where the *Lathryus* is produced, pre-harvest conditions for improved storage life need to be studied. The Group felt that this could form a good project for training at institutes like NBPGR which are willing to facilitate this type of studies.

F. Outcrossing and seed regeneration
Considering the extent of variation in outcrossing in *Lathyrus*, the Group felt that there is a need to standardise the regeneration technique and provide protocols for seed regeneration for the *ex situ* genebanks. Estimation of outcrossing rates in the locations where the *Lathyrus* accession will be regenerated is important.

G. Assessment of diversity
The Group strongly expressed the need for the assessment of genetic diversity in *L. sativus* and its relatives, using phenological, morphological and molecular markers, needs to be carried out to better understand the extent and distribution of the genetic diversity in the

materials already available. This will also help in the classification of available diversity from different regions and help mapping genetic diversity to identify gaps in future collections. When the analysis is carried out on *in situ* material, then this will also help in the identification of sites for *in situ* conservation. This could be extended to different species of *Lathryus* to determine phylogenetic relationships and geneflow. Herbarium surveys along with ecogeographic studies in conjunction with above suggested that genetic diversity studies will help us to better understand the genetic diversity for its efficient utilization in *Lathyrus* improvement.

H. Biotechnology

Need for promoting the use of biotechnological methods where possible was recognised by the Group as another area for the Network to pursue. The resistance to *Ascochyta* blight resistance genes from *Lathyrus* could also be transferred to other crops like peas. The genes for ODAP biosynthesis could be identified and transgenic *Lathyrus* lines can be produced with either low or no ODAP, or with other improved nutritional qualities such as higher methionine in the seed. For example, the work that Dr. S.L. Mehta had started, but now abandoned since the production of low ODAP somaclones, can be revitalised. Genetic transformation may prove more useful as this can help in altering only the ODAP trait in otherwise locally adapted landraces, thus helping to continue genetic diversity on farms. Regenerating *Lathyrus* plants from callus tissues derived from different parts of the plant and from different varieties, is now being routinely done in several laboratories in India, the U.K. and Belgium. The main or single focus of this work has been to attain low or zero-ODAP lines. Other favourable traits such as pest resistance, frost and drought stress tolerance, higher content of essential amino acids etc, need to be promoted. Conventional methods of wide crossing and embryo rescue could also be used for traits such as disease resistance etc. (**prepared for the Group by Dr. V. Ramanatha Rao**, **IPGRI-APO**)

Genetic resources of grass pea (*Lathyrus sativus* L.) in Bangladesh

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Introduction

Grass pea (*Lathyrus sativus* L.), locally known as *Khesari*, is a protein-rich legume grown in harsh conditions of dry to lowlying, water-logged and flooded land. The crop is widely cultivated in Bangladesh, India, Myanmar, Nepal and Pakistan in cold winter months under rainfed condition. It is also grown to a small extent in the middle Eastern countries, Southern Europe, and parts of Africa and South America. In Bangladesh, grass pea is cultivated in an area of about 231 343 ha with annual production of 182 000 mt of grain, the mean yield being 750 kg ha^{-1} (BBS 1995). Among the pulses, it occupies the highest area (33%) and production (34%).

Grass pea is the hardiest of the pulse crops because it can tolerate flooding, drought, and moderate soil salinity. This attribute has made it a very popular pulse crop as food and cattle feed among the poor farmers of Bangladesh. It is commonly cultivated as a relay crop in the wet rice fields without any input and care.

Agroecological requirements

Adverse agricultural conditions exist in grass pea growing areas of Bangladesh. These range from very lowlying rice fields where flood water remains stagnant for a long period to very dry and saline conditions. When the flood water starts receding, the heavy clay soil looses its moisture so quickly that the sowing of crops in the following winter season becomes difficult. These harsh conditions of growing grass pea may be classified into three distinct environments.

Environment I

The central part of Bangladesh, characterized by heavy rainfall during monsoon (June/July-August) and inundation by flood water every year, falls into this catagory. With the stagnant water receding, the calcarious dark grey/brown soil loses its moisture at a much faster rate after rice harvest, making sowing of winter crops extremely difficult. The farmers under such conditions largely practise relay cropping of grass pea. Even the grass pea crop suffers from water stress with the advance of the winter season and its yield is thus reduced.

Environment II

The environment II includes northern part of Bangladesh having high temperature and practically no rainfall during the winter season. The grey terrace soil becomes very hard and cracks easily and no winter crop is grown during November to April. The farmers are forced to go either for relay cropping of grass pea with rice or keep the land fallow.

Environment III

This covers the entire coastal belt area facing the Bay of Bengal and is situated in Southern Bangladesh. The soil is Gangetic tidal flood plain/grey flood plain and saline. As the land is being exposed to salinity, it is impossible to grow other winter crops profitably. Therefore, the farmers of these areas either go for relay planting of grass pea with rice or keep the land fallow.

Germplasm collection

Until 1982, there were a few collections of grass pea germplasm. The collections were either damaged or lost due to lack of proper storage facilities. No passport data of these collections are available. A systematic collection programme was initiated in 1992 by Bangladesh Agricultural Research Institute (BARI) in collaboration with Directorate of Agriculture Extension (DAE) and 2078 accessions of grass pea from areas under environment II and III were collected. These collections have been stored at Pulses Research Centre (PRC) and Genetic Resources Centre (GRC) of BARI. In 1995, a collecting mission collected 62 accessions of grass pea from environments I & III under a BARI/CLIMA/ICARDA collaborative project entitled "Collection and Conservation of Bangladeshi landraces of Lentil and *Lathyrus*". Passport data sheets of all these collections are available at PRC/GRC, BARI. Half of the collected materials from each of these accessions were sent to ICARDA.

Germplasm evaluation

The germplasm collected from environments I, II and III was evaluated during 1993, 1994 and 1995 at BARI. Each entry was grown in 1.5 m row plot at a distance of 50 cm between rows. Data on days to 50% flowering, days to maturity, pod length, seeds per pod and 1000-seed mass were recorded. These germplasm were also analyzed for diaminoproponic acid (ODAP) content (Tables 1 to 3).

The germplasm collected from twenty-seven districts of Bangladesh under environment I was evaluated at BARI in 1996-97 and data on different characters of 748 accessions of grass pea are presented in Table 1.

Table 1. Range, mean, standard deviation (SD) and coefficient of variation (CV) of grass pea accessions collected from environment I

Characters	Range	Mean	SD	CV(%)
Days to 50% flowering	50-83	70.0	11.01	15.2
Days to maturity	102-125	114.0	5.62	4.1
Pod length (cm)	2.9-4.1	3.0	0.17	4.9
Seeds/pod (No.)	3.2-5.8	4.6	0.42	9.9
ODAP (%)	0.0857-0.2 307	0.1239	0.0466	29.9

A wide range of variation was observed in days to 50% flowering, seeds/pod and ODAP content. The highest CV was observed in ODAP content and the lowest in days to maturity.

The germplasm from environment II was evaluated at BARI during 1996-97 and data on different characters of 538 accessions are presented in Table 2.

Table 2. Range, mean, standard deviation (SD) and coefficient of variation (CV) of grass pea accessions collected from environment II

Characters	Range	Mean	SD	CV(%)
Days to 50% flowering	55-88	71.0	4.96	7.0
Days to maturity	105-119	113.0	3.81	3.4
Pod length (cm)	2.5-3.3	2.8	0.15	5.5
Seeds/pod (No.)	2.3-4.9	3.4	0.41	11.9
ODAP (%)	0.0817-0.2209	0.1512	0.0455	30.1

A wide range of variation was observed in days to 50% flowering, seeds/pod and ODAP content. The highest coefficient of variation was again observed in ODAP content and the lowest in days to maturity.

The germplasm from environment III was evaluated at BARI and data on different characters of 535 accessions of grass pea are presented in Table 3.

Table 3. Range, mean, standard deviation (SD) and coefficient of variation (CV) of grass pea accessions collected from environment III

Characters	Range	Mean	SD	CV(%)
Days to 50% flowering	43-82	69.0	10.09	14.6
Days to maturity	99-122	114.0	4.92	4.3
Pod length (cm)	2.8-3.6	3.2	0.15	4.8
Seeds/pod (No.)	3.4-5.7	4.4	0.35	8.0
ODAP (%)	0.0791-0.2315	0.1621	0.0545	28.2

A similar trend for variation was observed in days to 50% flowering, days to maturity, seeds/pod and ODAP content. The germplasm from the three environments were similar for days to 50% flowering and days to maturity. The germplasm accessions of environment II had lesser pod length and smaller seed size. The mean ODAP content was less for environment I collections (Table 4).

The detailed characterization and evaluation of these collected germplasm is underway with the financial assistance from CLIMA. After characterization, the collections will be conserved in GRC.

Table 4. Mean values of different characters for collections from environments I, II and III

Characters	Environment I	Environment II	Environment III
Days to 50% flowering	70.0	71.0	69.0
Days to maturity	114.0	113.0	114.0
Pod length (cm)	3.0	2.8	3.2
Seeds/pod (No.)	4.6	3.4	4.4
ODAP (%)	0.1239	0.1512	0.1621

Varietal improvement

BARI and Bangladesh Institute of Nuclear Agriculture (BINA) have the mandate to carry out research on grass pea. BARI uses conventional breeding techniques whereas, BINA applies nuclear techniques. So far BARI has released two varieties of grass pea viz., BARI-Khesari-1 and BARI-Khesari-2, having high yield and low ODAP content compared to local check (Table 5). The breeder seed of these varieties have been handed over to Bangladesh Agricultural Development Corporation (BADC) and Non-Governmental Organizations (NGO's) for multiplication. Since outcrossing occurs in grass pea, these seed multiplying agencies have been advised to grow the crop in isolation. To maintain purity of seeds the farmers will be supplied with seed every year (a particular variety for a particular locality).

Table 5. Average performance and ODAP content of the grass pea varieties released by BARI

Varieties	Days to maturity	Plant height (cm)	1000-seed mass (g)	Seed yield (kg ha^{-1})	ODAP content (%)
BARI-Khesari-1	115	70	64	1720	0.06
BARI-Khesari-2	115	70	68	1727	0.14
Local Check	112	60	40	1616	0.53

Seven entries alongwith local check were tested in four environments for the final year during 1995-96. The entries were sown in a randomised complete block design using 3 replications in 8m x 4m plots at a between row distance of 40 cm. Data on days to 50% flowering, days to maturity, 1000-seed mass, seed yield (kg ha^{-1}) and ODAP content (%) are presented in Table 6.

Table 6. Average performance of the entries in different locations

Lines	Days to 50% flower-ing	Days to maturity	1000-seed mass (g)	Seed yield kg ha^{-1} Joy+	Isd+	Rah+	Jes+	Mean	ODAP content (%)
112/14-1	85	114	51.0	1 105	911	651	1 655	1 105	0.272
112/15-1	84	116	61.0	1 735	1 200	612	1 625	1 293	0.280
112/7-2	85	116	64.6	1 239	1 132	612	1 481	1 119	0.285
114/26-1	84	115	64.4	1 664	1 718	573	1 712	1 417	0.178
114/6-1	87	116	52.5	942	1 393	495	1 643	1 118	0.275
110/3-1	91	112	62.0	908	1 171	814	1 436	1 082	0.233
104/11-1	86	116	60.7	1 638	1 661	547	1 384	1 308	0.100
Local check	90	119	60.3	1 378	1 390	468	1 251	1 122	0.533
F. test	*	**	**	**	**	**	NS	-	-
CV(%)	2.95	0.78	3.43	2.60	21.37	9.25	21.1		
LSD(0.05)	4.406	1.566	3.519	60.1	500.7	137.9			

* Significant at 5 % level of probability; ** Significant at 1 % level of probability.
+Joy - Joydebpur; Isd - Ishurdi; Rah - Rajshahi; Jes - Jessore

The entries 104/11-1 and 114/26-1 have been identified to be high yielding having low ODAP content compared to local check. So these entries will be proposed for registration/ release.

Cropping systems and agronomic practices

Agronomic research on grass pea has not been conducted in Bangladesh. Grass pea is grown popularly as a relay crop in low lying areas in broadcast *aman* rice field. Seeds are broadcast in the rice crop in wet soil from mid-October to end of November, 4-5 weeks before rice harvest. Seed rate of 30-40 kg ha^{-1} is used by the farmers. Growing of grass pea as intercrop with sugarcane in some upland sugarcane growing areas is gaining popularity only very recently. Some rhizobial strains compatible with grass pea nodule formation followed by increased yield have been identified by BARI, BINA and BAU (Bangladesh Agricultural University).

Lathyrism

Dry grass pea seed contains ODAP (ß-diaminopropionic acid), a water soluble substance which has been found to be toxic to human beings. If grass pea consumed continuously without processing as a substitute for cereals, this toxic substance can cause lathyrism, a neurologic disease and the consumer becomes crippled. There were a few suspected cases reported in Bangladesh after 1971 with the out break of famine. The cases were examined later on and it was found that the patient who took boiled grass pea *dal* continuously for 3-4 months without processing in place of rice or cereal had lathyrism. Soaking seed in water for 7-8 hours and then decanting off the water removes most of ODAP. The best way to avoid lathyrism is to develop and cultivate the low toxin varieties.

Consumption

Grass pea is mainly consumed as *dal* with rice. Boiled green pods and roasted seeds are also consumed by the villagers. Soaking the split seed overnight and decanting water has been found make the *dal* toxin-free and safe for consumption. But when *Khesari* powder (*besan*) is used for making *pakoras, chapatis, dalpuri* etc., the danger of lathyrism still remains.

Marketing

Majority of the farmers are poor and thus can not keep their produce for long. During harvest time the price becomes minimum when the farmers sell their crop. The price goes up as the season advances and the poor farmers are deprived of this high price. So, the price should be fixed before harvest and government agencies should procure as they do in the case of rice and wheat.

Research priorities

- Characterization and conservation of the collected germplasm.
- Breeding for short duration, salinity tolerant, disease resistant (downy and powdery mildew).
- Breeding for low toxin cultivars with better nutritional qualities for consumers' acceptance.
- Breeding cultivars suitable for relay and inter-cropping.

Importance of *Lathyrus* network

Lathyrus is one of the most important legume crops grown in Asia. The crop can be used both as a food for human and feed for cattle. No input is needed to grow this crop. Inspite of all the advantages, the area under this crop is not increasing because of its low yield and high ODAP content. Research programmes in the countries where the crop is grown get low priority and there is a need for strengtheing these adequately. In this context, developing a network of the *Lathyrus*-growing countries will help:

(i) in the collecting, characterization and documentation of *Lathyrus* germplasm,
(ii) in the exchange of germplasm, breeding materials and technology information,
(iii) better understanding of the socioeconomic conditions in the communites where *Lathyrus* is a likely source of protein and calories,
(iv) development of a sound seed distribution system in replacing the high ODAP cultivars with low ODAP ones, and
(v) promote *Lathyrus* as the most potential food source and stimulate global interest.

Conclusion

After the harvest of low land rainfed rice, a large area remains fallow during the winter season where grass pea cultivation can be expanded. Farmers prefer to grow this low input crop because of its versatility to grow well in water-logged, drought and saline conditions. The low toxin, bold seeded cultivar developed by BARI should reach the farmers without delay. Seed multiplication programme should be strengthened to ensure supply of quality seeds to farmers. The price of *Khesari* should be fixed before harvest and government agencies should go for its procurement. Low toxin, bold-seeded high yielding varieties suitable for relay cropping and dual purpose should be bred for commercial production.

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Status of *Lathyrus* genetic resources in India

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Introduction

Grass pea (*Lathyrus sativus* L.) known as *khesari* has unique adaptation to extreme harsh conditions of drylands. Its cultivation is mainly concentrated in Madhya Pradesh, Maharastra, Bihar and West Bengal especially as *utera* (relay crop). Exact statistics of its area under cultivation and production in the country are not available because of ban on its cultivation in certain states. It is estimated to be cultivated in an area of 0.5 million hectares, of which 80% lies in south-eastern Madhya Pradesh. It is observed that in the region where irrigation facilities are extended to winter crops, its area is declining countinuously causing fast genetic erosion. Thus, it is a major concern to collect and conserve the available variability. The National Bureau of Plant Genetic Resources (NBPGR) and the Indira Gandhi Agricultural University (IGAU), Raipur are involved in the conservation of genetic resources and development of high yielding and low toxic varieties.

The Indian subcontinent is very rich in genetic diversity. In the literature (Duthie 1902; Bamber 1916; Wealth of India 1948-76; Babu 1977; Tiwari 1979; Hooker 1876-96) nine species *viz. L. aphaca, L. pratensis, L. sphaericus, L. inconspicuus, L. odoratus, L. altaicus, L. lecteus, L. imphalensis and L. sativus* are reported to found in the Himalayan region (Singh and Chandel 1997).

Activities on genetic resources have been discussed in detail in last Regional Workshop held at IGAU, Raipur from December 27-29, 1995 (Arora *et al*. 1996). Hence, onward activities and developments are discussed here.

Genetic resources activities in *Lathyrus*

Germplasm status

The NBPGR as the nodal organization augmented indigenous and exotic collection of *Lathyrus* for use in crop improvement programme in India. Presently 2 563 accessions have been conserved in genebank under long-term storage. Beside these, active collections are being maintained at NBPGR Regional Stations, IIPR, Kanpur, and IGAU, Raipur (Table 1).

Table 1. Germplasm holdings maintained at different locations

Source	Accessions
Base collection maintained at NBPGR, New Delhi	**2 563**
Contribution from NBPGR, New Delhi	58
Contribution from NBPGR, Akola	146
Contribution from IGAU, Raipur	2 021
Contribution from IARI, New Delhi	338
Active collection	
NBPGR, New Delhi	300
NBPGR, Akola	146
IGAU, Raipur	2 600
IIPR, Kanpur	180

Germplasm collecting and introduction

NBPGR, New Delhi is also the nodal agency for germplasm collecting and conservation.

Not much germplasm was collected during the last two years. However, 45 new collections were made by Indian Institute of Pulses Research (IIPR), Kanpur from Uttar Pradesh during 1995-96. A total of 110 accessions were introduced. These accessions were evaluated and are being maintained as indicated in Table 2.

Table 2. Introduction of *Lathyrus* genetic resources

Lathyrus spp.	Source	Accessions	Recepient
Lathyrus tingitanus	South Africa	1	NBPGR, New Delhi
Lathyrus cicera	U.S.A.	1	IGAU, Raipur
Lathyrus ochrus	Germany	1	IGAU, Raipur
Lathyrus ochrus	Greece	6	IGAU, Raipur
Lathyrus sativus	Cyprus	7	IGAU, Raipur
Lathyrus spp.	Syria	5	NBPGR, New Delhi
Lathyrus spp.	ICARDA	45	IIPR, Kanpur
Lathyrus sativus	ICARDA	15	IGAU, Raipur
Lathyrus sativus	ICARDA	14	IGAU, Raipur
Lathyrus ochrus	ICARDA	15	IGAU, Raipur
Total		**110**	

Germplasm evaluation

Germplasm evaluation was independently taken up at IIPR, Kanpur, IGAU, Raipur and NBPGR Regional Station, Akola. Centrewise number of accessions evaluated and lines identified for economic triats are listed in Tables 3 and 4.

Range of variation for different characters varied from place to place for a set of accessions evaluated. In general, flowering and maturity periods were shorter at Raipur and Akola than at Kanpur, and pod bearing was better at Kanpur. ODAP content varied from 0.123 to 0.594 per cent.

Table 3. Evaluation of germplasm at different centres

Centres	Acc. No.	DF*		DM**		Plant height (cm)		Pods/ plant		Seeds/ pod		Seed yield/ plant (g)		ODAP (%)	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Akola 95-96	140	54	66	110	122	43	114	28	132	2.6	5.3	0.6	19.7	-	-
IIPR 95-96	153	63	111	123	144	56	164	20	257	1.2	5.4	-	-	-	-
IIPR 96-97	124	54	107	124	147	44	142	14	98	2.0	4.0	-	-	-	-
IGAU 96-97	110	49	67	89	112	23	68	7	56	-	-	0.5	9.0	0.123	0.594

*Days to 50% flowering; **Days to maturity

Genotypes identified for different traits

Akola Centre

Earliness (<114 days)	IC 12466, IC 120473, IC 120490, IC 120472, IC 120507, IC 120420, IC 12049, IC 120596
Higher Pods/ Plant (>70)	IC 12507, IC 120497, IC 120537, IC 120422, NIC 18768, IC 18849, IC 18851, IC 18890
Higher Yield	IC 120479, IC 120512, IC 120526, IC 120530, IC 120531, NIC 18768, NIC 849, NIC 890, S-270, P-72, P-176

Raipur Centre

Earliness (< 90 days)	EC 200325, EC 209076, EC 208952, EC 208930, EC 209024, EC 208994, EC 208938, EC 209046, RLK 10012, RLK 3, RLK 4, RLK 5, RLK 6, RLK 7, RLK 8, RLK 9, RLK 10, RLK 11, RLK 12, RLK 13, RLK 14, RLK 15, RLK 16, RLK 17, RLK 18, RLK 19, RLK 20, RLK 21, RLK 22, RLK 23, RLK 24, RLK 25, RLK 26, RLK 27, RLK 28, RLK 29, RLK 30, RLK 31, RLK 32, RLK 33, RLK 34, RLK 35, RLK 36, RLK 37, RLK 38, RLK 39, RLK 40, RLK 42, RLK 43, RLK 44, RLK 47, RLK 48, RLK 49, RLK 50
Higher Pods/ Plant (>30)	EC 208930, EC 208944, EC 209033, RLK 1037
ODAP (<0.20 %)	BIO L-222, LS 155-6, LS 157-12, LS 157-14
Grain yield/ Plant (>5.0 g)	EC 200322, EC 208930, EC 208994, EC 208942, EC 209046, EC 200326, EC 209065, EC 208952, EC 209021, EC 20906, EC 209041, EC 209059, RLK 1012, RLK 1020, RLK 1043, RLK 1045, RLK 1046

Morphological variability observed

A. Flower colour

White	:	Raipur white 14, Bio L 208, EC 208930, EC 208944
Pink	:	EC 200330, JRL 2
Blue keel-white standard	:	EC 209032, EC 200325, EC 200629, EC 209026
Pink keel-blue standard	:	EC 209887, EC 209863, EC 200326
Royal Blue	:	EC 209041, EC 208942, EC 208955

B. Seed colour

Grey mottled	:	Common colour
Cream (white)	:	Raipur white-14, Bio L 208, Sel 453, Sel 456, Sel 463, Sel 471, Sel 536, Sel 565
Pink	:	RLS 6
Green	:	RLK 195
Black	:	RLK 2005

C. Other traits

Tetrafoliate	:	RLK 199
Double podded	:	DL 241

Screening of germplasm against pest and diseases

Fifty six accessions were screened for three years (1994-95 to 1996-97) against thrips (*Caliothrips indicus*), a major pest of *Lathyrus*. Though there was no regular trend in genotypic resistance, RLK 273-1 and RLK 273-3 exhibited moderate resistance against this pest. Similarly *L. cicera* and *L. odoratus* showed resistance against pod borers.

Genetic studies

Genetic divergence

From a study of 126 collections (68 indigenous and 58 exotic), it was inferred that no geographical diversity exists among the genotypes studied. Mehra *et al*. (1996), Vedna Kumari *et al*. (1993) had also reported that seed ODAP was not involved in the genetic diversification of grass pea.

Table 4. Screening of exotic accessions for ODAP content at IGAU, Raipur

Country of introduction	Accessions introduced	Accessions analysed	ODAP estimation (%) Range
Lathyrus sativus			
Canada	6	6	0.180 - 0.554
France	7	5	0.526 - 0.697
Bangladesh	3	2	0.411 - 0.431
Germany	3	3	0.337 - 0.445
U.S.A.	1	1	0.506
Italy	65	65	0.273 - 0.740
Syria	3	3	0.311 - 0.605
Ethiopia	14	14	0.622 - 0.765
Tunisia	1	1	0.332
Poland	1	1	0.332
Cyprus	3	3	0.305 - 0.372
Turkey	4	4	0.327 - 0.379
Greece	1	1	0.434
Total	**112**	**109**	**0.180 - 0.765**
Lathyrus ochrus			
Germany	1	1	0.416
Greece	6	6	0.472 - 0.505
Cyprus	7	7	0.442 - 0.490
Total	**14**	**14**	**0.416 - 0.505**

Table 5. Cluster composition in *L. sativus*

Cluster	Number of accessions		
	Indigenous	Exotic	Total
I	27	-	27
II	-	16	16
III	5	2	7
IV	7	17	24
V	11	-	11
VI	3	10	13
VII	6	6	12
VIII	2	1	3
IX	7	5	12
X	-	1	1

The study further revealed that there was highest inter-cluster distance between cluster I and X, VIII and X. Genotypes falling in these clusters having maximum divergence be chosen for hybridization programme.

Table 6. Ranking of clusters for important traits

Characters	Maximum				Minimum	
	1	2	3	4	1	2
Seed yield	VIII	X	IV	II	I	V
Seed index	III	V	VII	IV	I	X
Seeds/plant	X	IV	VIII	VII	V	I
Pods/plant	IV	VIII	X	II	V	I
Days to maturity	VI,II,X,IV	IX	VII	VIII	V	I
ODAP content	III	II	VI	IX	VII	VI

Outcrossing in Lathyrus sativus

Lathyrus sativus is a self-pollinated crop but some extent of out-crossing is also reported (Mehta and Santha 1996). A pilot study has been initiated since 1995-96 to know the extent and mode of out-crossing. EC 209080 and DL 241 (White flower), JRL 2 (Pink flower) and EC 208929 (Blue flower) were grown surrounded by blue flowered Pusa-24, during winter of 1995-96. All seeds harvested were grown in winter 1996-97. Off plants observed in white and pink flowered parents showed very limited out-crossing (0.199 to 2.267 %) in *Lathyrus* (Table 7). For confirmation of out cross/admixtures, the studies are in progress to observe for segregation, if any.

Table 7. Frequency of plants observed in segregating generation

Accessions grown	Total plants	Blue flower	Outcross (%)
EC 209080 (White flower)	136	2	1.47
DL 241 (White flower)	133	3	2.26
JRL 2 (Pink flower)	502	1	0.199

Inheritance of flower colour

Blue is the common flower pigmentation in *Lathyrus*. Vedna Kumari *et al.* (1996) have reported four genes responsible for flower pigmentation. A study has been initiated to know the genetics of flower colour and its relation with ODAP content if any. Freqency observed for different flower colours in F_2 populations of these crosses are presented in Table 8. For further confirmation, F_3 progenies have been sown during winter 1997-98. In two crosses between Blue x White, monogenic segregation was noted while in other two crosses it was digenic.

Table 8. Frequency distribution in F_2 generation

Crosses	F_1	F_2				
		Blue	White	Pink	Total	Ratio
1. RW-14 x P-24 (WxB)	Blue	385	171	-	556	3:1
2. P-24 x RW-14 (BxW)	Blue	311	109	-	420	3:1
3. RW-14 x RLK 1422 (WxP)	Blue	435	118	33	586	12.3:1
4. P-24 x RLK-1422 (BxP)	Blue	204	-	22	226	15:1

Genetics of neurotoxin content

With the development of low neurotoxin lines it has become interesting to know the genetic behaviour of neurotoxin in *Lathyrus* seeds. F_1, F_2 and back cross generations of the following four crosses involving high and low ODAP parents attempted during winter, 1995-96 have currently been sown in winter, 1997-98.

1. Bio R 203 x Bio I-222 (Low x Low)
2. Bio R 203 x RLK 1098 (Low x high)
3. Bio I-222 x Bio R-231 (Low x Low)
4. Bio I-222 x Pusa-24 (Low x Medium)

In previous studies (Dahiya 1985; Quadar *et al*. 1985; Campbell and Tiwari 1995) Pusa-24 and LS 8545 (0.20% ODAP) were used as low ODAP parent. In the present study parents having less than 0.10 per cent ODAP are involved. Large number of single plants will be analysed for ODAP content from F_2 and backcrosses. This will need additional human resources and chemicals. Hence, national and international collaboration will be useful in the completion of the study.

Development of low ODAP varieties

Large number of low ODAP strains have been developed through conventional breeding and biotechnology. Ratan (BioL-212) as a result of biotechnology has been released for general cultivation in India. Though the seed multiplication and distribution of low ODAP varieties is being taken in Madhya Pradesh, Bihar and Maharashtra, yet an ambitious seed production and replacement of local varieties by newer ones will be taken on priority. As this compound is showing inconsistency over the varying environments, efforts should be made to breed varieties with stable low ODAP content. Some lines developed at Raipur are

Table 9. Breeding varieties for low ODAP

Strains	ODAP (%)			
	1994-95	1995-96	1996-97	Average
LS 157-2-8	0.077	0.068	0.082	0.076
LS 157-14-5	0.090	0.082	0.086	0.087
LS 157-5-14	0.057	0.087	0.080	0.075
LS 157-5-20	0.084	0.083	0.075	0.081
LS 157-5-19	0.094	0.099	0.082	0.092
LS 157-18-14	0.080	0.079	0.093	0.084
LS 157-12-8	0.084	0.083	0.081	0.083
LS 157-12-4	0.069	0.066	0.067	0.068
LS 157-14-11	0.088	0.086	0.076	0.083
LS 157-5-18	0.093	0.082	0.095	0.090
LS 157-10-3	0.097	0.077	0.083	0.086
LS 185-11-6	0.086	0.082	0.093	0.087
LS 57-11-5	0.086	0.083	0.097	0.088
LS 157-2-4	0.098	0.086	0.077	0.087
LS 157-2-14	0.094	0.074	0.071	0.079
LS 157-2-12	0.098	0.079	0.082	0.086
LS 157-5-2	0.090	0.096	0.069	0.085
LS 157-5-3	0.073	0.088	0.071	0.077
LS 157-5-10	0.077	0.092	0.094	0.088
LS 157-6-5	0.096	0.093	0.093	0.094
LS 157-12-6	0.089	0.075	0.085	0.083
LS 185-11-5	0.086	0.083	0.097	0.088
Pusa 24	0.344	0.436	0.246	0.343

showing stability over the last three years (Table 9). These are being further tested in multilocational trials.

Future thrust

Exploration

Explorations should be made jointly by NBPGR and State Agricultural Universities to collect the variability/diversity from the unexplored areas, especially in the Himalayan region. The following priority areas/gaps have been identified by NBPGR for explorations:

Madhya Pradesh

(i)	Chhattisgarh region	:	Bilaspur, Raigarh, Bastar, Balaghat
(ii)	Bundelkhand region	:	Chhatarpur, Damoh, Sagar, Tikamgarh, Jhansi, Panna,
(iii)	Central M.P.	:	Seoni, Chhindwara, Jabalpur, Raisen, Narsinghpur, Vidisha, Bhopal, Sehore, Hoshangabad, Rewa, Satna, Sidhi.
(iv)	Malwa region	:	Shajapur, Dhar, Indore, Jhabua, Mandsaur
(v)	Nimar region	:	Khandwa, Khargone

Orissa

(Northeast region) : Sundergarh, Sambalpur, Koraput

Maharashtra

(Eastern region) : Chandrapur, Nagpur, Bhandara, Garhchicholi and Adjoining areas.

Bihar : Chota Nagpur, Ranchi, Sitamarthi, Gopalganj, Muzaffarpur, Purnea, Sharsha, Munger, Katiar, and adjoing areas of West Bengal.

Germplasm evaluation and characterization

Of the 2 604 accessions of *Lathyrus* being maintained at IGAU, Raipur, 1 187 accessions have been characterized and documented. Rest are to be evaluated for value added descriptors. NBPGR has already initiated this activity. Evaluation for morpho-physiological traits could jointly be done at IGAU, Raipur and NBPGR regional station Akola; ODAP estimation will be done at Raipur.

Lathyrus cicera is another grain species which should be tested for adaptation and valuable genes to be utilized in breeding programme. It has low ODAP and is resistant to pod borers.

Augmentation of soil microbes

ODAP-degrading soil microbes have been isolated from drain near IARI, New Delhi (Mehta and Santha 1996). Indian Council of Agricultural Research (ICAR) has already initiated activity for the conservation, production and exploitation of these microbes/bacterial races for the production of toxin free *Lathyrus*.

Need for Lathyrus network

Lathyrus being the underutilized crop invites the attention of the international scientific group. It needs proper programming and financial assistance for genetic improvement. During the first Regional workshop (1995) it was felt to have a strong network among the countries where it is grown or some research/development work on this is going on. Countries from South Asia, Africa and International Centres like ICARDA, CLIMA, FAO and IPGRI should be included in the Network. IPGRI has the mandate to advance the conservation and use of plant genetic resources, and to provide asssistance to the developing countries. IPGRI South-Asia office at New Delhi should act as coordinator and partner countries be identified for the network. Similarly, network within each partner country should also be strengthened. Working centres/institutes and their priority activities should be identified.

For vital and effective programme execution, a steering committee/working committee may be constituted. For this purpose, CWANA network may be taken into account while organizing South Asia Network.

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Need for a crop network on *Lathyrus* genetic resources for conservation and use

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Introduction

South Asian countries account for about 40% of the area under pulses and 27% of the world's production. More than 87% of the production comes from India alone with an annual production of about 16 m tonnes. The average yield is low, at about 600 kg ha^{-1} against 847 kg ha^{-1} at the world level. The yield gains have generally been low ranging from 0.3% in Bangladesh to 2.1% in Sri Lanka. Pakistan has registered a yield decline of 2.6% per annum during the decade ending 1994. Promotion of *Lathyrus* cultivation, crop improvement and its safe use for human consumption/animal feed is likely to mitigate declining trend in pulse production. At the same time, certain production areas/pockets turning into drought or flood prone and degraded or denuded soil cover could still be put to use by as hardy a crop as *Lathyrus.* The trend of area, production and yield in India from 1989-90 onwards have been given in Table 1. *Lathyrus* crop improvement through germplasm utilisation made in the past resulted in the development of about 16 cultivars along with some promising germplasm/donor stocks (Table 2). Distribution of different *Lathyrus* species in the country and the present status of germplasm holding received from different sources/institutes and maintained in the National Genebank as base collection are given in Tables 3, 4 and 5, respectively.

IPGRI has so far developed the crop network models and operational strategies of about 18 crops for various regions of the world. *Lathyrus* has also been considered a suitable candidate crop for such a network. This crop has a very special significance in India. Being possibly the most drought tolerant among *Rabi* (winter grown) pulses, it can be cultivated under conditions of moisture stress where no other pulse crop would grow. However, its cultivation generated a lot of controversy in the seventies, which is still continuing, as the neurotoxin (BOAA or ODAP) present in the seeds is held responsible for a paralytic disorder of lower limbs, especially when *khesari dal* forms a major component of daily diet. Under constant pressure from medical and nutrition experts, some states like Maharashtra, prohibited its trade, which continues even today, although no convincing case of lathyrism has been reported for the last 2-3 years.

Inspite of all the publicity, cultivation of *Lathyrus* is favoured due to its unique adaptation to harsh climatic situations. It is, therefore, necessary to undertake network approach for development of suitable varieties combining high yield with low neurotoxin content, preservation of genetic resources through *ex situ* and *in situ* conservation and sustaining its production levels.

The main impediments for *Lathyrus* crop improvement and increase in production are given below:

1. Non-availability of widely adapted varieties for various ecological zones/regions and their use in upland and *utera* systems of cropping.
2. Unstable behaviour of yield and neurotoxin content of the existing varieties.
3. Non-availability of suitable varieties resistant to biotic stresses such as thrips and powdery mildew.
4. Imposition of ban on trading of *khesari dal* in the country.

There is a global need to undertake research and development activities, including conservation, management and sustainable use of *Lathyrus* genetic resources, in a cohesive

Table 1. State wise area, production and average yield per hectare of *khesari*

States and Districts		1980-81	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
Assam	*A	9.2	NA	NA	NA	NA	NA	NA	NA
	*P	3.8							
	*Y	413.0							
Bihar	A	447.8	312.0	317.0	304.1	271.0	208.3	207.7	203.3
(Ranchi,	P	277.4	219.1	223.2	240.2	212.1	169.1	186.8	197.1
Sitamarhi, Gopalgunj, Muzaffarpur, Purnia, Saharsha, Munger, Katiar)	Y	620.0	702.0	703.0	790.0	783.0	812.0	899.0	970.0
Madhya Pradesh									
(Chhattis-	A	682.1	497.3	524.0	674.9	625.9	601.8	682.5	656.4
garh	P	220.3	162.1	202.2	278.1	329.8	290.1	376.7	338.5
region, Rewa, Satna and Durg)	Y	323.0	326.0	386.0	412.0	527.0	482.0	552.0	508.0
Maharashtra									
(Bhandara,	A	134.7	45.6	46.7	44.8	39.8	37.3	38.4	25.9
Chanderpur,	P	14.5	24.4	19.7	14.2	4.2	8.1	16.9	21.3
Nagpur)	Y	184.0	501.0	429.0	400.0	216.0	254.0	432.0	400.0
West Bengal									
(Jalpaiguri,	A	134.7	45.6	46.7	44.8	39.8	37.3	38.4	25.9
Cooch Bihar,	P	49.5	35.2	35.0	29.1	25.3	43.1	40.1	20.8
north and south Dinapur Malda, 24 Parganas, South Howrah and Midnapur east, Murshidabad and Nadia)	Y	368.0	772.0	749.0	650.0	636.0	1155.0	1044.0	803.0
Total	A	1 352.6	903.4	934.1	1059.3	956.1	879.3	967.7	948.8
	P	565.5	440.8	480.1	561.6	571.4	510.4	620.5	577.7
	Y	418.0	488.0	514.0	530.0	598.0	580.0	641.0	609.0

*A - Area in thousand ha, * P - Production in thousand tonnes, * Y - Yield kg ha^{-1}

mode. International Center for Agricultural Research in the Dry Area (ICARDA) has suggested/initiated new crop breeding strategies, which would ensure food supply to the

Table 2. Cultivars developed and promising germplasm/donors identified

Phase/year	Objectives	Name of cultivars/ promising germplasm	State/area of production
Phase I 1940-1960	Collection of local landraces and isolation of single plant progenies for superior yield	T-2-12, No. 11, No. 91, BR-13, LC 76 and B-19	Madhya Pradesh, West Bengal
Phase II 1974-90	Low ODAP (0.2%) and for upland cultivation	Pusa 24	Widely adaptable
	Low ODAP (0.15-0.2%)	LSD-1, LSD-2, LSD-3, LSD-6, Pusa-305 and Sel. 1276	(Upland areas) *Utera*
Phase III 1990's	Good yielding with low ODAP	RL-6, RL-8 and LS 157-14	Madhya Pradesh, Maharashtra
	Useful germplasm/ donors	Sel-521, Sel-443, Sel-519 and Sel-536	Introduced from ICARDA
	Low ODAP content	LS-8246 and LS-8545	Introduced from Canada
	Powdery mildew tolerant	RPLK-26, JRL-41 and Ris-2	Central Zone
	Tolerant to thrips	JRL-41, JRL-6	Raipur (Madhya Pradesh)
	Good yield with high Harvest Index (H.I.)	Bio R-202 Bio L-203 Bio L-212* Bio R-231 Bio L-208	Promising germplasm

* Identified for North Eastern Plain Zone (NEPZ) and Central Zone (CZ) with low ODAP (0.7%), high yield potential (16 q ha^{-1}) and bold seeds

poor people. Accordingly, its two fold approach, as given below, is worth consideration at the regional/country levels and would be useful in arriving at suitable decisions for the proposed network on *Lathyrus*:

1. Breeding crops that give greater yield, stability and ensure food security in the world's harshest/fragile environments and
2. Conserving the genetic diversity, while using diversity *in situ*/on-farm, and involving the farmers in this process, for their primary concerns.

Future thrust

Areas to be explored

Efforts have been made to find the gaps for further augmenting the germplasm through collections of the landraces/wild species from the already known sources, micro-centres, mosaic situations and fragile environments. The priority areas would be based on rate/extent of germplasm erosion, resulting from the development of new irrigation sources and mechanised agriculture operations. Some of the priority areas/gaps have been identified and are given as below:

- Chhatisgarh region : Bilaspur, Raigarh, Raipur, Rajnandgaon, Durg
- Bundelkhand region : Rewa/Satna, Chhatarpur
- Orissa (Northeast region) : Sundargarh, Sambhalpur, Koraput
- Eastern Maharashtra : Chardrapur, Garchiroli, Nagpur and adjoining areas
- Chhota Nagpur region : Ranchi, Sitamarhi, Gopalganj, Muzaffarpur, Purnea, Saharsha, Munger and Katiar and adjoining areas of West Bengal.

Table 3. Distribution of various *Lathyrus* species in India

Source: Singh and Chandel (1996)

Species	Habit	Distribution	Altitude	Use
L. aphaca	Annual	Plains of West Bengal to Kashmir and Kumaon, South Nilgiris	2 100 m	Fodder
L. sativus	Annual	Northern plains, Central India, Maharashtra, Southern India and Eastern Himalayas	1 300 m	Grain
L. tingitanus	Annual	An introduction from North Africa		Green manure/ fodder/ ornamental
L. sphaericus	Annual	North-west provinces: Bundelkhand region to Punjab, Western Himalayas and West Bengal	1 800 m	
L. inconspicuus	Annual	Plains and in Western Himalayas	2 000 m	
L. odoratus	Annual	Madhya Pradesh and sub-tropical region		Ornamental
L. altiacus	Perennial	Western Himalayas; Chenab valley	2 500 m	
L. luteus	Perennial	Western Himalayas; Punjab to Kumaon and Khagan region	3 000 m	
L. imphalensis	Perennial	Manipur	1 200 m	Fodder
L. pratensis	Perennial	Wester Himalayas; Garhwal region to Kashmir	1 800 m	Dual purpose

Table 4. Germplasm holdings maintained as base collection in the national genebank from different sources

Source	No. of Accessions			Year of supply
	Indigenous	Exotic	Total	
NBPGR, New Delhi	57	1	58	1993
NBPGR, Akola	146	0	146	1995
IGAU, Raipur	1 061	0	1 061	1995
IGAU, Raipur	960	0	960	1995
ICARDA, Syria	0	11	11	1996
IARI, New Delhi	264	74	338	1997
Total	2 488	86	2 574	

Table 5. Germplasm holdings maintained as active collection in the IN-PGR system

Institute	No. of accessions
NBPGR, New Delhi	311
NBPGR, Akola	146
IGAU, Raipur	2 600
IARI, New Delhi	338
Total	3 395

Inventorisation of bio-physical resources

Inventorisation of bio-physical resources (soil, water, climate, flora, fauna) in different ecophysical regions, along with the different habitats, cropping systems and particular landraces, local cultivars, etc.

Augmentation of soil microbes germplasm

It would be desirable to have a research activity on the lines already initiated by the Indian Council of Agricultural Research (ICAR), for the exploitation of suitable microbe/bacterial races. This would further help improve cultivar production potential as well as in isolating the ODAP-degrading gene from the soil microbes.

Germplasm characterization for value addition

The NBPGR has been looking for cooperating institute for evaluation of germplasm collection for various traits particularly those influencing value addition. This would include basic studies pertaining to genetic potentials of different species for the production of biomass/ grain/fodder/dual purpose/straw feed, ornamental purposes, disease and pest resistance and low neurotoxin content. These activities would thus require infrastructure development and financial support to the cooperating centres/institutes for conducting laboratory/field studies besides strengthening of storage facilities.

The international nursery testing and other breeding materials should also be made available to farmers for participatory plant breeding approach. This would help exploit the maximum genotype x environment interactions for specific adaptations under mosaic situations.

The breeding efforts in the past were uni-directional and focused on improving grain production which has adversely affected the quality and quantity of biomass of the released cultivars. There is need to re-focus the objectives. Due importance should be given for the improvement of quality and quantity of the crop residues based on joint product analysis of the end products, i.e., grain and straw which would be attained through breeding for dual purpose varieties. On this score, morphological indicators for assigning quality of crop residue should be used in the descriptors such as leaf : stem ratio, stay-green character and high foliage/forage/feed potential.

Role of NBPGR in the proposed network

IPGRI's initiative of developing a network on *Lathyrus* is timely and is likely to meet the common objectives of the on-going crop improvement programmes of the countries. It would certainly address the specific problems of the regions/sub-regions/zones by sharing of information and materials for achieving the objectives/targets set forth. The role of NBPGR in the proposed network operations, attuned with its mandate and in conjunction with the activities of the IN-PGRS as governed by the Bureau, is structured as below:

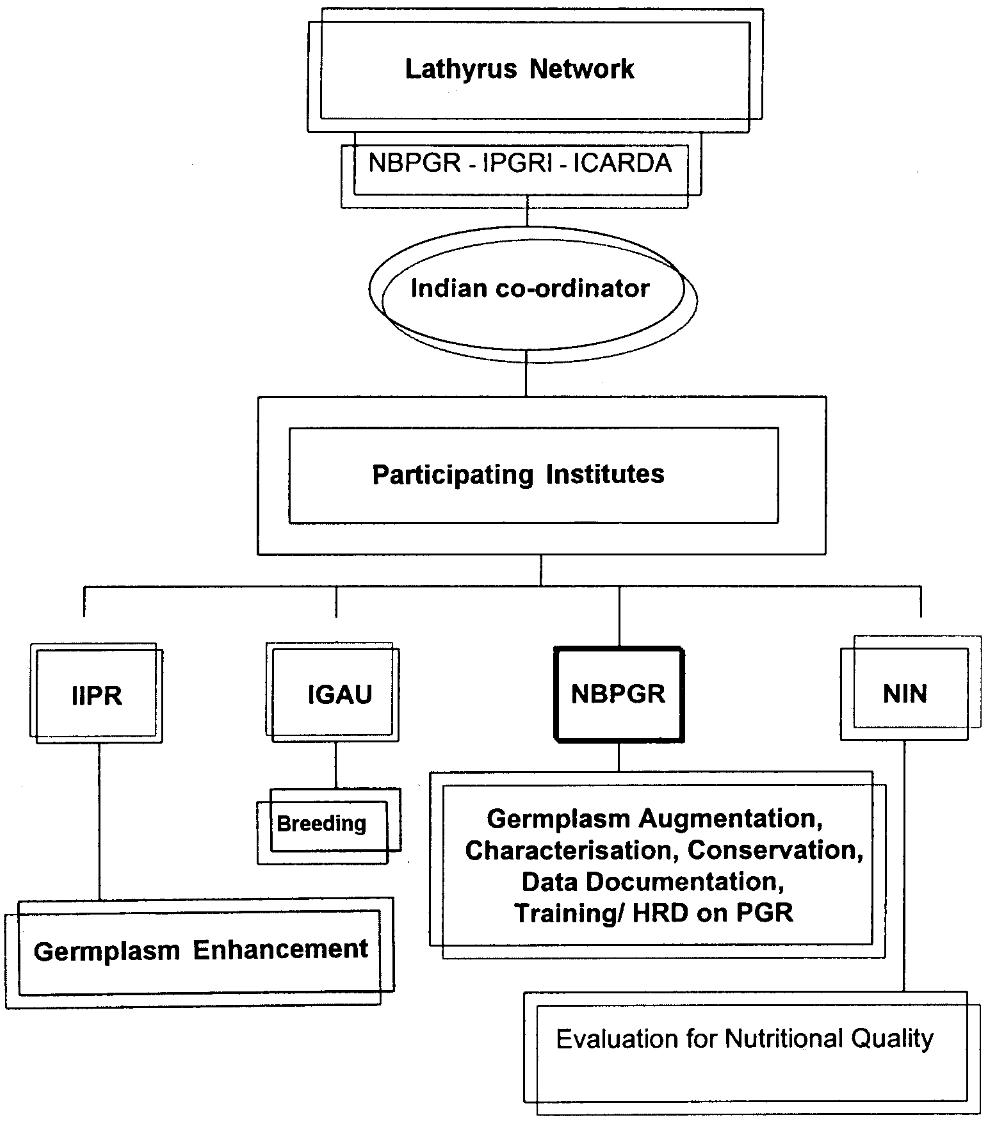

Fig. 1. Proposed operational structure for *Lathyrus* improvement in India

Identified activities/areas of work

1. Revision/upgradation of descriptor list of *Lathyrus* spp. in association with IPGRI/ ICARDA.
2. Development of core collection of the national base collection/regional holdings.
3. Characterization, evaluation and documentation of germplasm under the IN-PGRS for value addition traits.
4. Strengthening of *ex situ* collections, including duplicate safety collection sets.
5. Indigenous knowledge data bank and pilot scale *in situ* conservation studies for the development of farmer's participatory plant breeding programmes for enhancement of germplasm.
6. Germplasm/genetic stock registration.
7. Imparting on-job training/human resources development on PGR in the Asian region.

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Status of grass pea (*Lathyrus sativus* L.) genetic resources in Nepal

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Introduction

Grass pea (*Lathyrus sativus L.)* known as *khesari* in Nepal, is one of the important grain legumes. Its total area under cultivation, production and productivity has however declined over recent years (Table 1). His Majestry Government has imposed ban on its cultivation in Nepal since 1991-92 due to presumed neurological disorder called lathyrism. However, it still occupies substantial area and is second to lentil among all pulses grown in the country. Also, historically grass pea has been banned by many countries, but it is still produced in significant quantities in many parts of the world (Campbell 1989).

Table 1. Area, production and productivity of grass pea in Nepal (1985-86 to 1995-96)
Source: CBS 1996.

Year	Area ('000 ha)	Production ('000 mt)	Productivity (kg ha^{-1})
1985-86	53.30	28.12	527
1986-87	53.98	28.92	537
1987-88	44.02	19.57	443
1988-89	38.58	19.81	513
1989-90	38.13	21.19	556
1990-91	40.86	22.99	563
1991-92	38.72	20.70	535
1992-93	40.06	20.04	500
1993-94	40.88	21.00	514
1994-95	38.07	19.34	508
1995-96	34.20	17.20	500

Grass pea is mostly relayed with rice under marginal or zero level of inputs. It is an important food, feed and fodder crop. Despite its tolerance to drought, grass pea is not affected by excessive rainfall and can be grown on land subject to flooding (Campbell *et al*. 1994). In Nepal and other adjoining countries, grass pea is often broadcasted into standing crop of rice about 1 to 2 weeks before the rice harvest, where it flourishes on residual soil moisture after the rice has been harvested (Bharati 1986). Grass pea can be grown in all soil types including very sandy loam soil to heavy clays as it has a very hardy and penetrating root system. This hardiness together with its ability to fix atmospheric nitrogen makes the crop well designed to grow under adverse conditions (Campbell *et al*. 1994).

Grass pea is an important food item. Most often it is used as *dal* (an aqueous slurry cooked with spices), *atta* (flour boiled in water) and *satu* (roasted flour mixed with water). It is often used as adulterant to chickpea and pigeonpea *dal* or flour (Bharati and Neupane 1989). The young plant is used as leafy vegetable, eaten with rice meal. It is also an excellent fodder and green manure crop. After harvesting, the dried straw and chaff are fed to farm animals.

Germplasm collection

The first systematic collecting for grass pea was organized in April - May 1987 by Nepal Agricultural Association (NAA) in collaboration with International Development Research

Centre (IDRC), Canada. Seventy six accessions were collected from 18 districts of Nepal (Adhikary *et. al.*, 1987). Subsequently, a total of 107 landraces of grass pea were collected with the funding support of CLIMA during 1995. These collections included material from terai and inner terai districts from east of Karnali river of the mid-western part of Nepal. Experts from CLIMA, ICARDA and NARC participated in the expedition led by Dr. Larry Robertson from ICARDA. These materials have been received by CLIMA and ICARDA for long-term storage.

In 1987, selected local genotypes were crossed with genotypes with low ß-N-oxalyl-L-α, ß-diaminopropionic acid (ODAP) content at Manitoba, Canada. The segregating population was grown at Rampur during 1990-91. Most of the lines did not set flowers and the remaining lines did not set fruits (Neupane 1995). At present, research work in grass pea is almost absent except for maintenance of germplasm. However, National Grain Legume Research Programme (NGLRP), Rampur is seeking access to low ODAP containing lines of grass pea from any external source as far as possible.

Germplasm characterization and evaluation

Grass pea germplasm collected during 1987 were grown at NGLRP, Rampur for characterization and evaluation (Furman and Bharati 1989). Passport information of 87 grass pea germplasm accessions are presented in Table 2. Data on 13 agro-morphological characters were also recorded and are presented in Tabale 3.

A wide range of variability (Furman and Bharati 1989) was recorded in plant height, number of pods per plant, seeds per pod, 100 seed mass and grain yield of genotypes under study (Table 4). Seventeen exotic grass pea germplasm lines introduced from Canada were also evaluated at Parwanipur (*terai* location). In general, local accessions were well adapted, high yielding and early maturing, but had smaller seed size than the exotic ones (Bharati and Neupane 1988). Evaluation, characterization and documentation of germplasm accessions collected during 1995 from western parts of Nepal is yet to be undertaken.

Germplasm conservation

One set of both local and exotic collections of grass pea germplasm are being maintained at NGLRP headquarter at Rampur, using upright freezers. Duplicate set of germplasm collected during 1987 has been sent to Canada through IDRC for long-term storage. Germplasm collected during 1995 through CLIMA/NARC collaborative programme has

Table 2. Passport information for *Lathyrus* germplasm accessions
Source: Furman and Bharati (1989)

Accession number	Accession name	Country of origin	Province of origin	Location of origin/source	Other names
1	2	3	4	5	6
Lth0001	LS-34	Nepal	-	Phanse Bauimiga	-
Lth0002	LS-37	Nepal	Saptari	Paunia Raipur	NAA 42
Lth0003	LS-61	Nepal	Nawalparasi	Wargauli	-
Lth0004	LS-58	Nepal	Bara	Buniyad	NAA 67
Lth0005	LS-32	Nepal	Mahottary	Mahottary Bazaar	NAA 32
Lth0006	LS-71	Nepal	Jhapa	Dulabari	NAA 56
Lth0007	LS-53	Nepal	Bara	Tokani Rampur	NAA 69
Lth0008	LS-49	Nepal	Siraha	Matiarhwa	NAA 62

Contd...

Table 2. (Continued)

1	2	3	4	5	6
Lth0009	LS-42	Nepal	Siraha	Lahan	NAA 60
Lth0010	LS-44	Nepal	Saptari	Inaruwa	NAA 45
Lth0011	LS-63	Nepal	Chitwan	Mungalpur panchayat	NAA 75
Lth0012	LS-62	Nepal	Citwan	Mangalpur Bazaar	NAA 76
Lth0013	LS-38	Nepal	Saptari	Topa village	NAA 43
Lth0014	LS-08	Nepal	Sarlahi	Nawalpur side	-
Lth0015	LS-03	Nepal	Nawalparasi	Tilkapur	NAA 9
					-
Lth0016	LS-07	Nepal	Nawalparasi	Magarkota Panchayat	NAA 10
Lth0017	LS-05	Nepal	Nawalparasi	Magarkota Panchayat	NAA 7
Lth0018	LS-06	Nepal	-	-	-
Lth0019	LS-04	Nepal	Nawalparasi	Arunkhola gram	NAA 8
Lth0020	LS-09	Nepal	-	Babhiliya	-
Lth0021	LS-02	Nepal	-	-	-
Lth0022	LS-26	Nepal	Rautahat	Baidyanathpur	-
Lth0023	LS-25	Nepal	Rautahat	Bahera, Chainpur	NAA 26
Lth0024	LS-28	Nepal	Sarlahi	Judhpani	NAA 29
Lth0025	LS-29	Nepal	Sarlahi	Judhpani, Nawalpur	NAA 30
Lth0026	LS-30	Nepal	Siraha	Mahadewa village	-
Lth0027	LS-27	Nepal	Rautahat	Chandranigapur	NAA 25
Lth0028	LS-24	Nepal	Rautahat	Gaidaja	-
Lth0029	LS-87	Nepal	Bara	Nautar Batwar	-
Lth0030	LS-55	Nepal	Bara	Buniyad	NAA 71
Lth0031	LS-57	Nepal	Parsa	Shripur, Birgunj	NAA 70
Lth0032	LS-67	Nepal	Morang	Rangeli Village	NAA 53
Lth0033	LS-64	Nepal	Morang	Tarbesha Village	-
Lth0034	LS-46	Nepal	Dhanusha	Birhipur	-
Lth0035	LS-33	Nepal	Dhanusha	Saphi Village	-
Lth0036	LS-47	Nepal	J Sunsari	Jadhganj	NAA 46
Lth0037	LS-52	Nepal	Bara	Khutwas	-
Lth0038	LS-40	Nepal	Mahottary	Sahora village	NAA 35
Lth0039	LS-54	Nepal	Bara	Mushri	-
Lth0040	LS-74	Nepal	Jhapa	Gaila Durwa	NAA 58
Lth0041	LS-72	Nepal	Morang	Amardah	NAA 54
Lth0042	LS-75	Nepal	Jhapa	Birtha Bazaar	NAA 59
Lth0043	LS-73	Nepal	Jhapa	Charali	NAA 57
Lth0044	LS-63	Nepal	Morang	Rakhuwa Vill. Panchayat	NAA 49
Lth0045	LS-67	Nepal	Morang	Ranjah Village	NAA 51
Lth0046	LS-31	Nepal	Mahottary	Sahorwata	NAA 31
Lth0047	LS-20	Nepal	Banke	Ranjhara Village	-

Contd...

Table 2. (Continued

1	2	3	4	5	6
Lth0048	LS-30	Nepal	Saptari	Joginia village	NAA 44
Lth0049	LS-21	Nepal	Banke	Nepalgunj	-
Lth0050	LS-22	Nepal	Kapilbastu	Birpur	NAA 22
Lth0051	LS-23	Nepal	Kapilbastu	Krishnanagar	NAA 23
Lth0052	LS-76	Nepal	Nawalparasi	Parasi	NAA 24
Lth0053	LS-59	Nepal	Bara	Tajpur Lipani	NAA 72
Lth0054	LS-10	Nepal	Jhapa	Garamani	NAA 55
Lth0055	LS-68	Nepal	Morang	Chowada village	NAA 52
Lth0056	LS-73	Nepal	Jhapa	Charali	NAA 57
Lth0057	LS-36	Nepal	Sraha	Baluwa village	NAA 40
Lth0058	LS-41	Nepal	Dhanusha	Belachapi Naktajheyh	NAA 36
Lth0059	LS-50	Nepal	Parsa	Sukchaina	NAA 63
Lth0060	LS-60	Nepal	Chitwan	Jagatpur	NAA 73
Lth0061	LS-31	Nepal	Mahottary	Sahora	NAA 31
Lth0062	LS-43	Nepal	siraha	Bairia Lahan	NAA 61
Lth0063	LS-66	Nepal	Morang	Aaptola Village	NAA 50
Lth0064	LS-17	Nepal	Kapilbastu	Badara	NAA 15
Lth0065	LS-11	Nepal	Rupendehi	Dudhraj	-
Lth0066	LS-14	Nepal	Rupandehi	Bangai	NAA 13
Lth0067	LS-12	Nepal	Rupandehi	Dugada	NAA 12
Lth0068	LS-16	Nepal	Banke	Tingharena Panchayat	NAA 16
Lth0069	LS-19	Nepal	Banke	Pipera Thute Pipal	NAA 19
Lth0070	LS-13	Nepal	Rupandehi	Bangai	NAA 14
Lth0071	LS-18	Nepal	Banke	Maita	NAA 17
Lth0072	LS-01	Nepal	Nawalparasi	Bargadai	-
Lth0073	Local	Nepal	Dhanusha	-	D-21
Lth0074	Local	Nepal	Parsaa	-	P-1
Lth0075	Local	Nepal	Siraha	-	S-1
Lth0076	Local	Nepal	Siraha	-	S-2
Lth0077	Local	Nepal	Siraha	-	S-3
Lth0078	Local	Nepal	Dhanusha	-	D-2
Lth0079	Local	Nepal	Siraha	-	S-23
Lth0080	Local	Nepal	Parsa	-	P-20
Lth0081	Local	Nepal	Sikraha	-	S-26
Lth0082	Local	Nepal	Parsa	-	P-24
Lth0083	NC8A-64	USSRI	-	-	-
Lth0084	NC8A-74	India	-	-	-
Lth0085	NC8A-96	India	-	-	-
Lth0086	NC8A-97	Bangladesh	-	-	-
Lth0087	NC8A-76	India	-	-	-

Table 3. Characterization and preliminary evaluation data for *Lathyrus* germplasm accessions
Source : Furman and Bharati (1989)

Acc. No.	Days Flr	Days Mat	GRO Hab	Pl Type	LFWD	PLHT	POD Plnt	Seed Pod	Seed wt	KGHA	Seed col
1	2	3	4	5	6	7	8	9	10	11	12
Lth0001	83	135	2	1	3	54.2	35.0	4.3	4.0	1367.5	brown grey
Lth0002	90	134	1	2	3	54.6	43.4	4.2	5.0	1077.8	brown grey
Lth0003	88	134	1	2	3	58.8	47.6	3.8	4.1	1367.5	red grey
Lth0004	82	133	-	2	3	60.4	43.0	4.1	4.3	1348.3	brown grey
Lth0005	88	136	1	2	3	52.4	44.8	4.6	3.7	827.8	red grey
Lth0006	90	136	2	2	5	66.4	40.6	3.9	4.0	1102.8	brown grey
Lth0007	82	134	1	2	3	57.4	39.4	4.1	4.1	1312.0	grey
Lth0008	80	135	1	2	3	61.0	41.4	3.4	4.1	917.0	grey
Lth0009	81	133	3	2	3	60.8	56.8	3.6	4.0	855.3	brown grey
Lth0010	91	136	2	2	3	53.8	92.2	3.3	3.3	1113.3	brown grey
Lth0011	86	136	3	2	3	65.0	61.6	5.5	3.8	1204.0	brown grey
Lth0012	86	136	2	2	3	59.6	66.0	3.8	4.4	1483.0	red grey
Lth0013	80	135	1	2	3	48.0	18.2	2.9	3.6	1026.0	grey
Lth0014	86	137	3	2	3	75.6	65.8	5.5	6.1	1022.3	brown grey
Lth0015	86	137	1	2	3	69.4	76.6	4.2	4.4	1240.0	red grey
Lth0016	86	136	2	2	5	67.0	67.6	3.9	4.8	1215.8	brown grey
Lth0017	90	136	1	2	3	64.2	57.0	3.0	4.4	1203.8	red grey
Lth0018	87	136	3	2	5	76.4	53.8	4.0	4.0	1729.8	brown grey
Lth0019	90	136	1	2	3	64.8	59.2	2.9	3.2	839.3	brown grey
Lth0020	86	137	2	2	5	72.0	63.8	3.8	4.5	1267.5	brown grey
Lth0021	86	136	2	2	5	62.0	76.2	4.8	5.1	1313.0	grey
Lth0022	86	136	1	2	5	57.8	33.2	3.7	4.6	1274.3	grey
Lth0023	87	137	3	2	5	68.2	70.4	4.4	3.2	1386.0	broen grey
Lth0024	85	137	1	2	3	61.0	91.4	3.8	4.1	1610.0	broen grey
Lth0025	86	137	3	2	3	64.0	88.0	4.2	4.2	1495.0	brown grey
Lth0026	82	135	2	2	3	57.0	47.4	3.0	4.1	1648.0	brown grey
Lth0027	85	136	1	2	3	56.4	68.6	4.3	3.5	1534.0	brown grey
Lth0028	85	136	2	2	5	63.0	49.8	3.8	3.4	1485.0	brown grey
Lth0029	85	137	2	2	5	55.0	52.0	4.1	4.5	1387.8	grey
Lth0030	85	137	3	2	5	59.0	81.6	3.8	4.0	1456.3	brown grey
Lth0031	82	137	1	2	3	60.6	51.2	3.4	4.5	1493.3	grey
Lth0032	83	136	1	2	3	61.0	50.8	3.9	4.0	1408.5	brown grey
Lth0033	85	137	2	2	3	46.8	34.8	4.4	4.4	1496.3	brown grey
Lth0034	85	139	1	2	3	50.4	30.2	3.9	4.2	1496.8	grey
Lth0035	85	139	1	2	5	56.0	53.4	3.9	5.5	1302.8	grey
Lth0036	90	139	2	2	5	54.8	34.2	3.0	4.0	1409.0	brown grey
Lth0037	82	135	1	2	3	45.0	59.0	5.1	4.8	1380.5	grey
Lth0038	83	136	2	2	3	44.0	31.6	4.5	3.5	1192.5	brown grey
Lth0039	82	136	1	2	3	52.0	31.8	4.5	4.0	1407.8	grey
Lth0040	90	137	2	2	5	53.2	34.8	3.8	4.4	1192.8	grey

Contd...

Table 3. (Continued)

1	2	3	4	5	6	7	8	9	10	11	12
Lth0041	90	139	3	2	3	43.0	48.6	3.8	4.2	1224.8	grey
Lth0042	90	139	3	2	3	50.2	39.0	3.0	3.8	1268.8	brown grey
Lth0043	90	139	2	2	3	51.0	53.4	4.2	4.0	1266.0	grey
Lth0044	85	137	1	2	3	44.8	42.6	3.4	3.4	1072.0	grey
Lth0045	86	137	1	2	3	42.0	27.6	4.3	3.2	1027.5	brown grey
Lth0046	86	137	2	2	3	46.0	33.2	3.6	4.2	1245.0	grey
Lth0047	91	139	1	2	3	52.2	26.2	4.3	4.3	497.5	brown grey
Lth0048	85	136	1	2	3	41.0	48.6	3.6	3.9	868.8	brown grey
Lth0049	87	139	1	2	3	56.0	63.6	3.6	5.0	468.5	brown grey
Lth0050	85	139	2	2	3	58.0	30.8	3.8	4.8	939.0	brown grey
Lth0051	82	135	1	2	5	58.0	37.4	4.4	5.5	669.5	brown grey
Lth0052	82	135	1	2	5	50.0	53.0	4.2	4.1	757.5	grey
Lth0053	83	135	2	2	3	57.2	36.2	3.9	4.2	1603.8	grey
Lth0054	93	139	2	2	3	64.0	69.4	2.9	3.4	1131.3	red grey
Lth0055	85	137	3	2	5	67.8	41.8	4.1	3.4	1216.3	red grey
Lth0056	91	139	2	2	3	55.0	41.2	3.3	4.0	1088.8	grey
Lth0057	80	135	2	2	3	56.6	38.2	3.6	4.8	954.5	brown grey
Lth0058	85	134	1	2	3	56.2	85.8	4.0	4.1	1083.5	brown grey
Lth0059	83	134	3	2	3	59.0	41.4	3.5	4.4	1291.3	brown grey
Lth0060	86	135	1	2	3	63.0	43.0	4.5	3.5	865.5	red grey
Lth0061	91	139	1	2	5	60.4	24.4	3.9	2.7	1283.8	red grey
Lth0062	82	133	1	2	3	52.2	37.2	3.2	3.5	1214.5	red grey
Lth0063	85	132	1	2	5	58.0	30.4	3.4	3.9	1443.3	red grey
Lth0064	85	133	2	2	5	63.8	32.2	4.5	4.6	1004.5	red grey
Lth0065	85	139	1	2	5	76.0	29.8	3.7	3.2	1326.0	red grey
Lth0066	85	137	1	2	5	75.0	24.4	4.3	5.4	1285.0	red grey
Lth0067	84	136	1	2	5	72.0	61.6	3.9	3.6	1503.0	brown grey
Lth0068	91	139	1	2	5	69.2	29.6	4.0	4.2	975.0	grey
Lth0069	85	139	2	2	5	74.6	38.8	3.5	3.0	1391.0	brown grey
Lth0070	85	139	1	2	5	61.0	25.4	4.0	4.3	1458.8	brown grey
Lth0071	82	139	2	2	5	66.0	43.2	3.7	3.2	1132.5	brown grey
Lth0072	85	139	2	2	5	69.2	38.2	3.8	3.0	1136.8	brown grey
Lth0073	79	133	1	2	3	55.0	57.2	3.5	4.6	847.8	grey
Lth0074	85	136	1	2	5	59.0	31.8	3.8	3.9	1294.3	brown grey
Lth0075	82	136	1	2	5	63.8	23.4	3.7	4.5	1313.5	red grey
Lth0076	82	135	1	2	3	53.0	40.4	4.3	3.1	1090.5	brown grey
Lth0077	82	134	1	2	3	58.8	26.0	3..2	4.1	1193.8	brown grey
Lth0078	82	133	1	2	3	64.0	29.6	3.3	3.4	1065.5	brown grey
Lth0079	77	134	1	2	3	48.6	28.2	3.4	3.4	552.0	red grey
Lth0080	85	134	2	2	3	43.0	31.8	3.1	4.0	544.3	grey
Lth0081	80	135	1	2	3	48.0	34.8	3.4	4.5	673.5	grey
Lth0082	77	132	2	2	3	50.0	31.4	3.1	4.2	342.8	brown grey
Lth0083	85	139	2	2	3	56.0	29.6	3.9	4.7	1374.8	brown grey
Lth0084	80	137	2	2	3	62.0	23.6	3.0	3.5	1129.5	brown grey
Lth0085	80	139	3	2	5	75.2	25.6	2.9	6.5	445.3	grey

Contd...

Table 3. (Continued)

1	2	3	4	5	6	7	8	9	10	11	12
Lth0086	85	136	-	2	3	49.0	49.0	3.5	3.0	429.3	grey
Lth0087	85	139	-	2	5	69.4	69.4	3.1	4.2	1048.8	grey

FLWRCOL - Flower colour of all accessions was blue (BL).

Acc. No. = Accession number, Days Flr = Days to 50% flowering, Days Mat = Days to maturity, GRO Hab = Growth habit, Pl Type = Plant type, LFWD = Leaf width, PLHT = Plant height (cm), POD Plnt = Pods per plant, Seed Pod = Seeds per pod, Seed wt = 100-seed mass (g), KGHA = Grain yield (kg ha^{-1}), and Seed col = Seed colour.

been taken by CLIMA, Australia for long-term storage with duplicate samples being kept at Plant Genetic Resources Unit at the Agriculture Botany Division, NARC, Khumaltar, Kathmandu for mediun-term storage.

Table 4. Variability in agronomical characters in 86 accessions of grass pea grown at Rampur during 1988

Characters	Mean	Minimum	Maximum	CV (%)
Days to 50% flowering	85.0	77.0	93.0	4.0
Days to maturity	136.0	132.0	139.0	1.4
Plant height (cm)	58.0	41.0	76.0	14.9
Pods per plant	46.0	18.0	143.0	43.7
Seeds per plot	3.8	2.9	5.5	14.3
100-seed mass (g)	4.1	2.7	6.5	16.4
Grain yield (kg ha^{-1})	1 160.0	343.0	1 730.0	25.9

Need for grass pea network

Grass pea will continue to play an important role in human protein needs and to maintain soil fertility and sustainability particularly in South Asian countries. It is a traditional crop grown mainly as a relay crop in rice-based cropping system. It has ability to withstand extreme moisture conditions (drought or excessive rainfall) and other productivity constraints (except thrips, downy mildew and powdery mildew). Future collaborative needs of the network are suggested as follows:

1. Germplasm collection from unexplored areas of each paricipating member countries of the network.
2. Free exchange of germplasm among grass pea growing countries and concerned IARCs to ensure better utilization of genetic resources to improve the crop through collaborating national programmes.
3. Setting of common regional observation nurseries and regional adaptation trials (of both early and full season groups as well as of both fodder and grain types).
4. Crossing of materials with specific qualities like for zero or low ODAP content at ICARDA/ICAR, etc., and then supplying early generation segregating materials (F_2, F_3, etc.) to network countries.
5. Knowledge of genetic control of the neurotoxin in grass pea is required for the development of low or no ODAP lines. Elimination of ODAP through biotechnological techniques would be of great significance.
6. Joint monitoring through visit of scientists among member countries of the network.
7. A socio-economic study to determine the extent of lathyrism is needed in Nepal, because no such work has been done so far. For this, a regional network project support (both technical and financial) will be highly useful.

Mechanism of operation of grass pea network

Sustainability of a grass pea network seems feasible because it is an important crop in South Asian countries and commitment among network cooperators has been expressed. However, both financial and human resources must be available to run the network. Key sustainability aspects of the network are suggested as follows:

1. Some common objectives of the network must be identified.
2. Plan for funding support from among the member countries, though it will be a donor supported project.
3. There should be agreed commitment or MoU of participating countries of the network.
4. A steering committee from among representatives of the member countries must be formed and it should have a coordinator to carry-out a leadership role for network activities.
5. Development of a database of grass pea germplasm resources among network member countries will be quite useful.

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Status of *Lathyrus* germplasm held at ICARDA and its use in breeding programmes

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Introduction

Grass pea has been widely cultivated in South Asia and Ethiopia for over 2500 years (Bell 1989) and is used as a food and feed. It is rich in protein content, around 30 g/100 g edible seeds (Aletor *et al.* 1994) and contains high amount of free L-homoarginine, which is a precursor of lysine in higher animals (Quereshi *et al.* 1977). Agronomically, the species is able to withstand both severe drought as well as water logging. During recent collections in Ethiopia and Bangladesh by ICARDA, it was noted that most farmers grew *Lathyrus* because of its water logging tolerance. In Ethiopia, *Lathyrus* was grown on heavy black clay soils with poor drainage and in Bangladesh, the most common cropping system was relay cropping of *Lathyrus* in rice, where *Lathyrus* was planted in the flooded paddy before it was drained and harvested.

The International Center for Agricultural Research in the Dry Areas (ICARDA) was given a regional mandate for the West Asia North Africa region (WANA) and for Ethiopia for crop improvement of *Lathyrus* species as forage legumes by the Consultative Group on International Agricultural Research (CGIAR) Centers. The WANA region is the center of origin and primary diversity for *Lathyrus* species (Zohary and Hopf 1988). In WANA, *Lathyrus cicera* (L.) is common in Cyprus, Greece, Iran, Iraq, Spain and Syria, and *Lathyrus ochrus* (L.) DC. in Cyprus and Greece, used mainly for feed and forage (Sexana *et al.* 1993). Work at ICARDA deals with three species; *L. sativus* (L.) (common chickling or grass pea), *L. ochrus* (L.) DC (ochrus vetch) and *L. cicera* (L.) (dwarf chickling). Additionally, there is a small amount of research with *L. ciliolatus* (L.) (underground chickling) which produces both underground and aboveground pods. The breeding work has concentrated mainly on the use of *Lathyrus* as a feed and forage legume with research on hay, straw and grain production. The Genetic Resources Unit of ICARDA supports this work by collecting, conservation, evaluation and genetic diversity research of *Lathyrus* species.

Though ICARDA originally was mandated a regional responsibility for *Lathyrus* research as a forage species, recently work has been initiated to develop a programme for improvement of *Lathyrus* as a pulse with emphasis on Ethiopia and Pakistan but also with consideration of the other countries of South Asia. The collecting and conservation of genetic resources of *Lathyrus* species, while concentrating in the ICARDA region has recently also entailed activities outside of this region since this material might prove useful for improvement of the crop.

Status of collection

The germplasm collection of *Lathyrus* maintained by ICARDA contains 44 species from 46 countries (Table 1) with a total of 3 038 accessions. These accessions are held in trust under the auspices of the Food and Agriculture Organization (FAO) under a CGIAR agreement with the FAO. All germplasm is distributed under a Material Transfer Agreement (MTA) to protect the rights of the country of origin of the germplasm.

Except for a large number of accessions of *L. sativus* received from the Bangladesh Agricultural Research Institute (BARI), the majority of the accessions are from WANA (Figures 1-6). In WANA the most accessions are from Morocco, Turkey and Syria. Additionally, a large number of accessions have also originated from Greece and Ethiopia.

Table 1. *Lathyrus* germplasm accessions held at ICARDA

Country	*L. sativus*	*L. cicera*	*L. ochrus*	Total
Afghanistan	19	-	-	20
Armenia	-	-	-	5
Australia	3	2	1	10
Azerbaijan	-	-	-	13
Bangladesh	1 115	-	-	1 115
Bulgaria	10	-	-	14
Canada	5	-	-	5
Switzerland	-	-	-	1
Czech Republic	8	1	1	11
Cyprus	20	-	22	43
Germany	5	1	1	13
Denmark	-	-	-	1
Algeria	-	12	3	33
Ecuador	1	1	-	2
Egypt	1	-	-	2
Spain	1	-	2	13
Ethiopia	178	-	-	180
France	1	-	-	3
United Kingdom	-	-	-	1
Georgia	-	-	-	10
Greece	20	48	29	110
Hungary	5	-	-	5
India	7	1	2	10
Iran	13	-	1	22
Iraq	-	-	-	10
Italy	-	-	3	3
Jordan	1	1	-	33
Morocco	14	31	9	152
Nepal	76	-	-	90
Pakistan	83	2	-	91
Palestine	-	-	1	3
Poland	-	-	-	1
Portugal	4	1	14	26
Russian Federation	-	1	-	3
Union of Soviet Socialist Republics	8	1	1	11
Slovak Republic	1	-	-	1
Sweden	-	-	-	1
Syprus	4	24	13	519
Tajikistan	-	-	-	8
Turkmenistan	-	1	-	10
Tunisia	16	2	30	39
Turkey	16	52	3	370
Ukraine	3	-	-	3
Uruguay	-	-	-	1
United States of America	1	-	-	1
Yugoslavia	-	-	-	1
Uzbekistan	-	1	-	12
Unknown	1	-	-	7
Total	1 627	183	136	3 038

Table 2. *Lathyrus* species held in the ICARDA germplasm collection

Species	No. of accessions	Species	No of accessions
L. amphicarpos	2	*L. incurvus*	2
L. angulatus	1	*L. latifolius*	1
L. annuus	68	*L. laxiflorus*	12
L. aphaca	260	*L. marmoratus*	34
L. articulatus	105	*L. nissolia*	9
L. aureus	1	*L. occidentalis*	1
L. basalticus	5	*L. ochrus*	136
L. belinensis	1	*L. odoratus*	3
L. blephariearpus	37	*L. pallescens*	1
L. cassius	8	*L. pratensis*	2
L. chloranthus	1	*L. pseudo-cicera*	66
L. chrysanthus	3	*L. rotundifolius*	2
L. cicera	183	*L. sativus*	1 627
L. cilicicus	10	*L. saxatilis*	2
L. ciliolatus	3	*L. setifolius*	7
L. clymenum	9	*L. sphaericus*	21
L. digitatus	2	*L. stenophyllus*	2
L. gloeospermus	2	*L. sylvestris*	1
L. gorgoni	60	*L. tingitanus*	18
L. hirticarpus	2	*L. tuberosus*	4
L. hierosolymitanus	110	*L. vinealis*	4
L. hirsutus	17	other species	44
L. inconspicuus	149	Total	3 038

A significant number of *L. sativus* accessions in the ICARDA germplasm collection, even discounting the large donation form BARI, are from South Asian countries (Figs. 2, 4 and 7). The largest number of accessions in the ICARDA germplasm collection are of *L. sativus, L. cicera, L. ochrus* and *L articulatus* (Table 2).

Recent germplasm collections (1992-1997) of *Lathyrus* species are given in Table 3. Nearly half of these collected germplasm accessions are of *L. sativus,* the rest being mainly of *L. cicera, L. ochrus* and *L. articulatus* (a potentially important species in Morocco). The majority of these accessions have been collected in WANA, though 32% were collected from countries of South Asia (Table 4). The majority of the accessions from WANA are from Syria and Morocco. A series of targeted missions were conducted in 1993-1995 in Morocco to fill a significant gap in representation of *Vicia* and *Lathyrus* species in the ICARDA and Moroccan collections. A significant number of accessions have also recently been collected in Ethiopia and two accessions were collected in Ecuador, where they have been used for human consumption since their introduction by the Spanish 400 years back.

Evaluation of germplasm

Results of characterization of 1 082 accessions of 30 species of *Lathyrus* have been previously reported by Robertson and Abd EI Moneim (1996). These accessions were characterized for 21 descriptors including phenological and agronomic traits. These evaluations showed useful variation in flowering date and seeds per pod for *L. cicera* and for flowering date for *L. ochrus.* This data is currently being prepared for a germplasm catalogue.

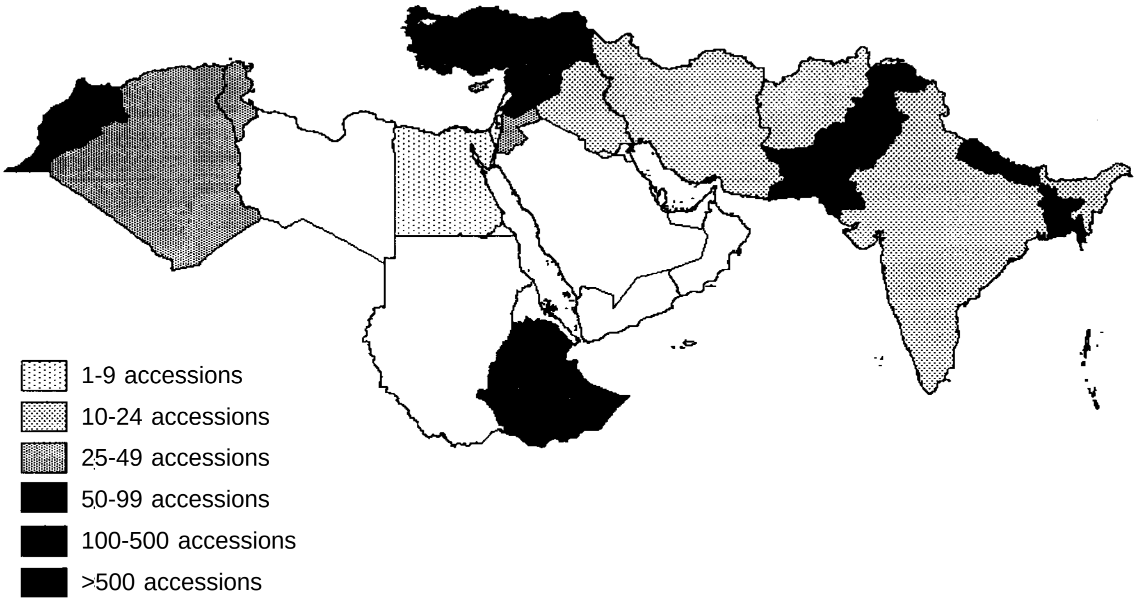

Fig. 1. ICARDA germplasm holdings of *Lathyrus* species

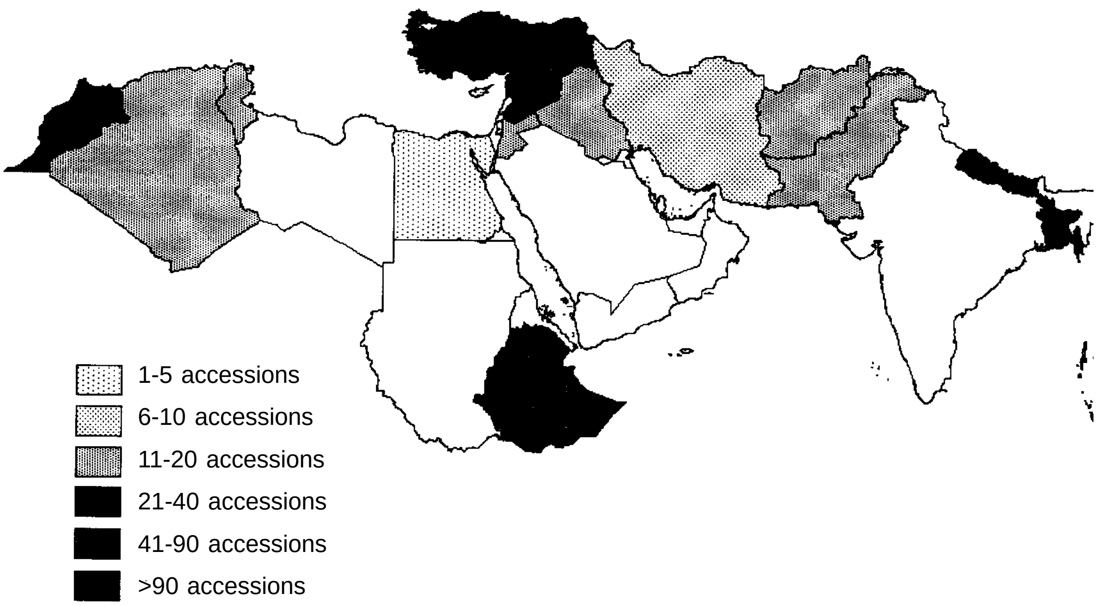

Fig. 2. ICARDA collected germplasm of *Lathyrus* species

Host-plant screening in *Lathyrus* species for resistances to powdery mildew (*Eryisphe pisi*), Botrytis blight (*Botrytis cicerea* Pers. Ex Fr.) and Ascochyta blight (*Ascochyta pisi* Lib.) have been previously reported by Robertson and Abd El Moneim (1996). Several resistance sources in *L. sativus* for powdery mildew and Ascochyta blight (dual resistance) have been found (Table 5). Accessions of *L. ochrus* have been reported that remain free of *Orobanche crenata* (Linke *et al.* 1993), though accessions of *L. sativus* and *L. cicera* were found to be highly susceptible to this obligate parasitic weed. Most accessions of *L. cicera* are resistant to cold, whereas *L. ochrus* and *L. sativus* are generally very susceptible to cold (Abd El Moneim and Cocks 1993). The reasons for this are that most *L. sativus* and *L. ochrus* accessions are from low altitude, mild winter environments, whereas many *L. cicera* accessions are from high altitude, continental environments with severe winters (Robertson and Abd El Moneim 1996).

Fig. 3. Distribution of *Lathyrus* germplasm in the ICARDA collection

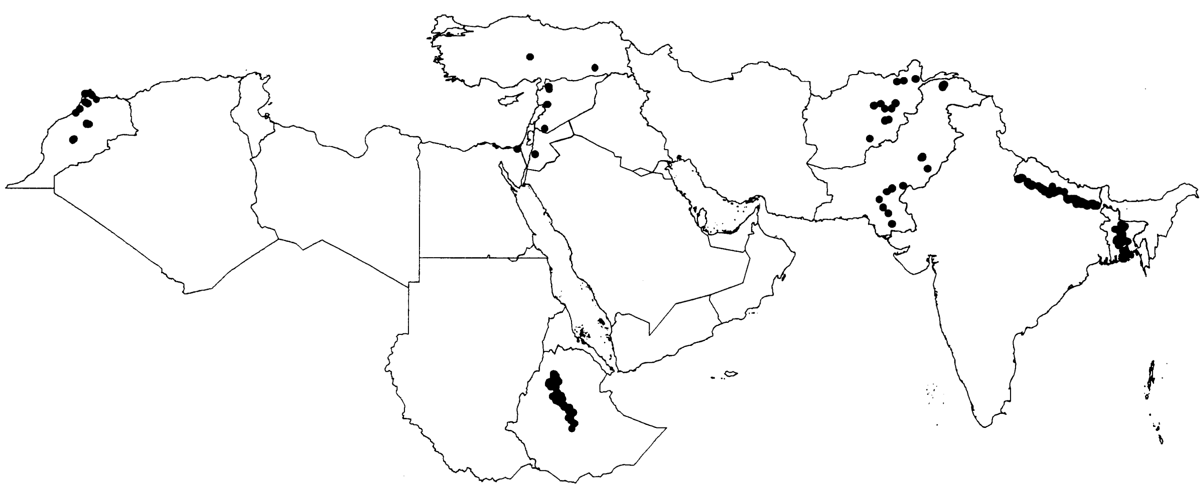

Fig. 4. Distribution of *L. sativus* germplasm in the ICARDA collection

Fig. 5. Distribution of *L. cicera* germplasm in the ICARDA collection

Fig. 6. Distribution of *L. ochrus* germplasm in the ICARDA collection

Table 3. Species of *Lathyrus* collected by ICARDA during 1992-97

Species	No. of accessions
L. angulatus	1
L. annuus	1
L. aphaca	33
L. articulatus	71
L. basalticus	1
L. blepharicarpus	4
L. chrysanthus	1
L. cicera	35
L. clymenum	9
L. gloeospermus	1
L. hierosolymitanus	8
L. hirsutus	1
L. inconspicuus	16
L. latifolius	1
L. ochrus	41
L. pseudocicera	11
L. sativus	222
L. saxatilis	1
L. setifolius	2
L. tingitanus	4
Other species	27
Total	491

Utilization of collections

The germplasm collections have been the basis for the development of breeding programmes at ICARDA for three species, *L. sativus, L. cicera* and *L. ochrus*. The objective of these breeding programmes is to produce varieties for WANA with high yield of herbage, seed and straw with abiotic and biotic stress resistances/tolerances (Table 6). Recently, ICARDA has decided

Table 4. Recent collections of *Lathyrus* germplasm by ICARDA

Country	Year	No. of accessions
Bangladesh	1995	62
Ecuador	1996	2
Spain	1997	10
Ethiopia	1997	70
Iraq	1995	3
Morocco	1993	108
Morocco	1994	23
Morocco	1995	14
Morocco	1997	3
Nepal	1995	90
Pakistan	1996	3
Syria	1992	14
Syria	1994	20
Syria	1996	11
Syria	1997	20
Tunisia	1992	4
Tunisia	1994	31
Total		488

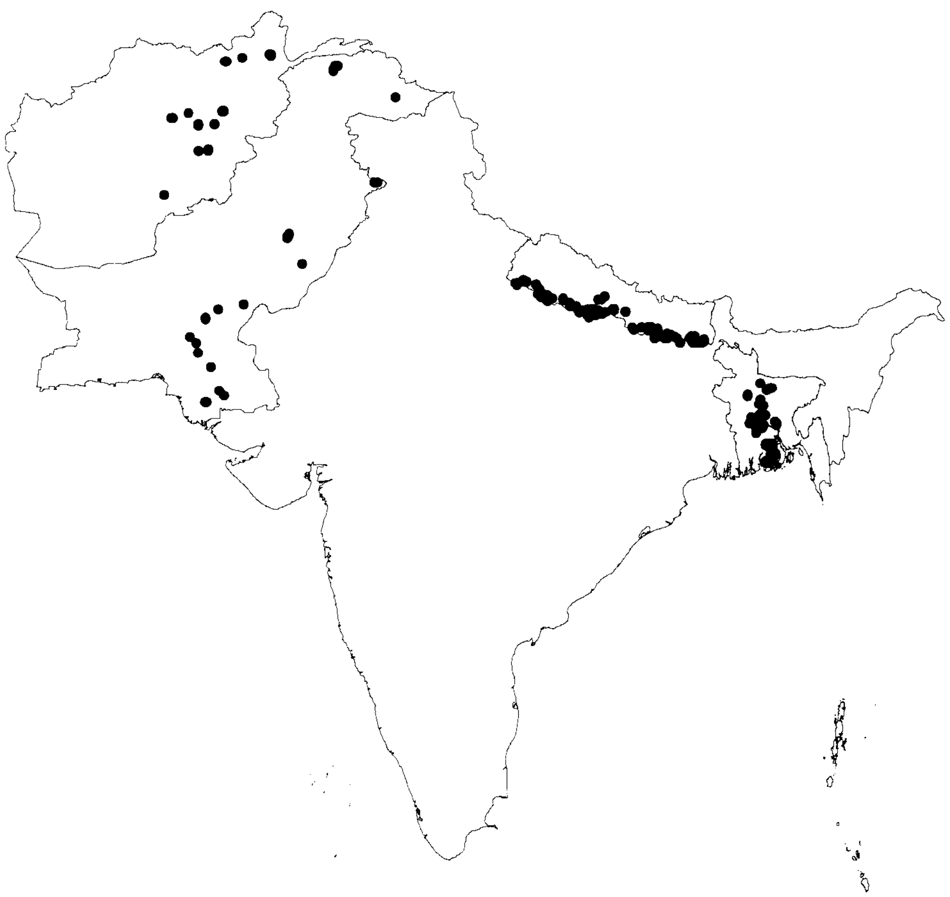

Fig. 7. Distribution of *Lathyrus* germplasm from South Asia in the ICARDA collection

Table 5. Resistant sources of chickling (*Lathyrus*) to cold, *Orobanche crenata,* downy mildew and ascochyta blight

Stress/Species	Resistant source
Orobanche crenata	
L. ochrus	IFLAO 84, 94, 95, 101
Cold	
L. ochrus	IFLAO 109
L. cicera	Most accession
Downy mildew and ascochyta blight	
L. sativus	Sel. 553, 555, 563, 529, 504

Table 6. Use and environmental adaptation of different species of *Lathyrus* in West Asia and North Africa

Species	Uses	Adaptation	Priority Research Objectives
L. sativus	GZ, G, S	<300 mm rain, moderate cold	Resistance to *Orobanche* and foliar diseases; high harvest index; low ODAP content
L. cicera	G, S	<300 mm rain, moderate cold	Resistance to *Orobanche* and foliar diseases; high harvest index; low ODAP content
L. ochrus	G, S	<300 mm rain, mild winters	Improved cold tolerance

to seek funding to start a project on the improvement of *L. sativus* as a pulse crop for countries in the ICARDA region (mainly Pakistan and Ethiopia) and also for countries of South Asia.

The improved germplasm developed from the breeding programme is distributed through an International Nursery Network. This programme has been successful in identifying cultivars for release because of the efforts of breeders and agronomists of national programme in testing the provided material for adaptation to local conditions. The national programme of Jordan has released one cultivar of *L. ochrus* (IFLAO 101/185).

Breeding programme

Objectives and methodology

Annual forage legumes species, including *Lathyrus* species, are one of the options to replace fallow in the cereal/fallow rotations in dry areas of WANA. They are defined as leguminous species sown and harvested in a single year. They can be used for grazing during winter and early spring and harvested either for hay in spring or for grain and straw at full maturity. The adaptation and use of *Lathyrus* species are shown in Table 6.

The objective of the ICARDA breeding programme for *Lathyrus* has been mainly to develop and produce improved cultivars to feed livestock in areas receiving less than 400 mm of rainfall (Table 6). It is also desirable to have widely adapted cultivars that can be recommended for different locations with similar agro-ecological conditions. While improving yield and adaptation to the environment, emphasis is also given to ensure that the palatability, intake and other nutritive values of herbage, hay, grain and straw are acceptable.

Two approaches are adopted to develop improved lines of *Lathyrus* (Fig. 8). In one, selection is affected in the wild accessions in the germplasm from the ICARDA genebank to develop improved cultivated types. In the second, hybridization is used to overcome specific shortcomings; shattering pods, prostrate growth, susceptibility to diseases and

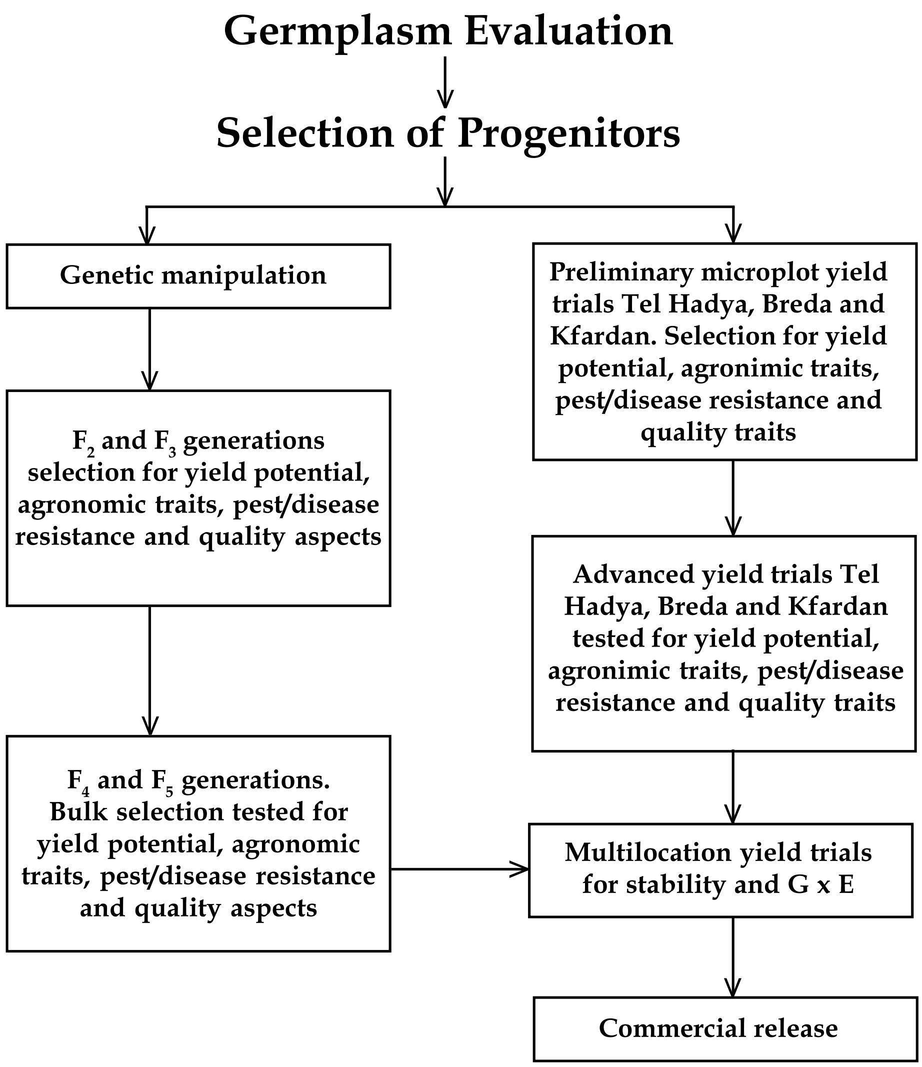

Fig. 8. *Lathyrus* breeding programme scheme at ICARDA

Table 7. Grain yield (kg ha^{-1}) of *Lathyrus sativus* breeding lines in 1995 at three sites in Syria

IFFLS/Statistic	Tel Hadya	Breda	K Fardan
567	1 187	684	1 117
504	1 130	756	1 083
516	1 084	624	1 000
528	1 188	616	983
531	1 136	710	933
Mean of trial	1 008	500	864
S.E.M.	90	29	107
C.V.	16.0	31.0	21.5

nematodes, cold susceptibility, high content of anti-nutritional factors, etc. The process begins and ends with on-farm studies to determine farmers' needs and to see how well the new improved cultivars meet them.

Yield and adaptation

Significant progress has been made for improvement for yield and adaptation to WANA region. Table 7 shows results for the five top lines of *L. sativus* for grain yield in advanced yield trials at three locations in Syria for 1995. Several lines yielded over 1 t ha^{-1} in environments of low rainfall. Similar progress has been made with the other species that are being bred.

Quality traits

The quality parameters utilized in the forage breeding programme are protein (%), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Dry Matter Organic Matter Digestibility (DODM %). Hays of *L. sativus* and *L. cicera* are high in protein content, NDF (%) and ADF (%), whereas, the hay of *L. Ochrus* is relatively low in protein content and fibre resulting in high digestibility (Table 8). This is mainly due to leafiness and relatively thick stems. The same trend has been found for straw.

Table 8. Mean and range of protein, NDF, ADF and DOMD for hay of three *Lathyrus* species in advanced yield trials at Tel Hadya

Species		Protein (%)	NDF (%)	ADF (%)	DOMD (%)
L. sativus	Mean	21.3	35.2	18.3	83.0
	Range	14-24	26-41	16-20	80-86
L. cicera	Mean	21.5	32.0	19.0	79.0
	Range	19-24	27-35	15-23	75-82
L. ochrus	Mean	17.5	26.0	17.0	86.0
	Range	14-24	19-29	14-23	82-89

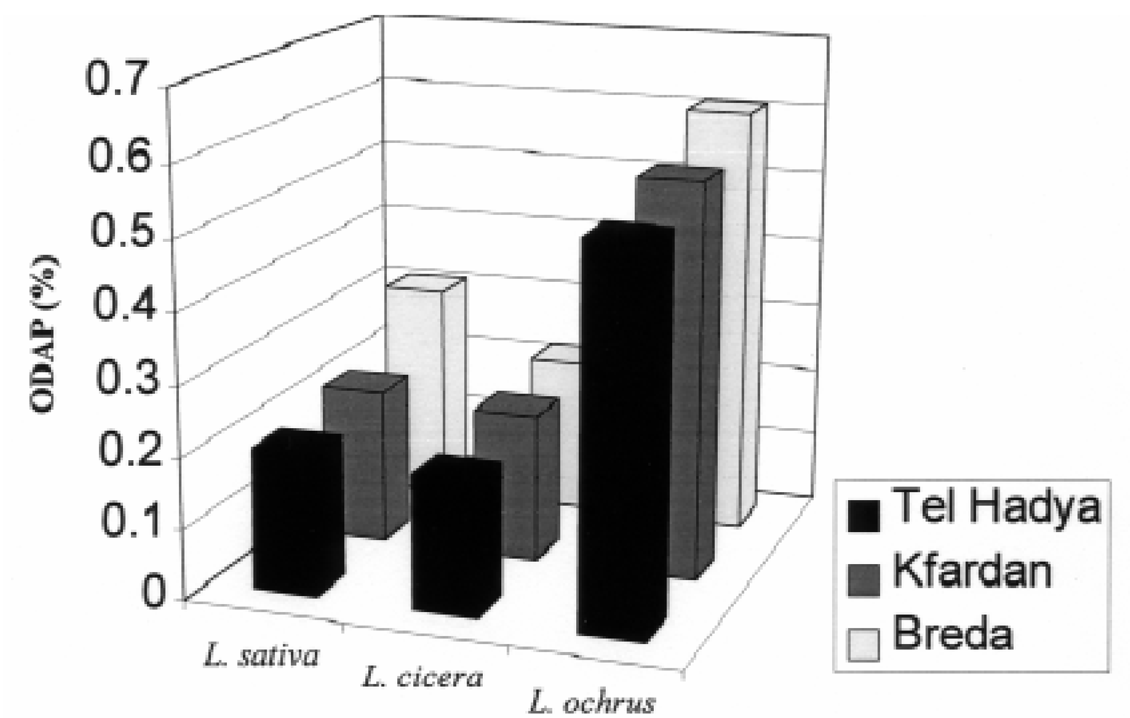

Fig. 9. ODAP content (%) of three *Lathyrus* species at three locations in Syria

Special attention has been given in *Lathyrus* species to evaluate for low concentrations of the free amino acid ß-N-oxalyl-L-α, ß-diaminopropionic acid (ODAP), a neurotoxin that causes a neural disorder resulting in incurable paralysis of the lower limbs of human beings or domestic animals. Evaluation of *L. sativus, L. cicera* and *L. ochrus* at three locations in 1995 showed large variation between species, between lines and between locations (Fig. 9). Breda (the lowest rainfall site) had the highest levels of ODAP. As previously seen at one location, *L. cicera* had the lowest and *L. ochrus* the highest ODAP content at all three locations.

A breeding programme with *L. sativus* was initiated at ICARDA in 1991-92 in which 21 high yielding *L. sativus* lines having ODAP content ranging from 0.27 to 0.75% were crossed with low ODAP lines. Due to transgressive segregation towards earliness and high ODAP content, a large proportion of F_2 populations matured earlier than the parents. Selection was done in F_3, F_4 and F_5 generations for early maturity, small and large seed size, white or light cream seed colour and a ODAP content less than 0.1 %. A total of 85 families with their parents, were grown under rainfed conditions at two locations viz., Tel Hadya and Breda, Syria, to assess their yield potential and ODAP content during 1996-97 growing season. Three families (19, 18 and 85) had shown low ODAP content (0.02, 0.07 and 0.06 per cent, respectively) and were characterized by white flowers and large white or cream coloured seed. The yield ranged from 0.9 to 1.5 t ha^{-1}. The effect of location on ODAP content was non-significant. The three low ODAP families were 10-15 days later in maturity than the lines with high ODAP content.

Distribution of germplasm

Germplasm of *Lathyrus* is distributed by ICARDA through two main mechanisms. Improved germplasm from the crop improvement programme is regularly distributed through an International Nurseries Network through a series of adaptation trials. Germplasm accessions are distributed upon request by the genebank at ICARDA under the conditions of a MTA mentioned previously.

The Genetic Resources Unit at ICARDA regularly distributes approximately 750 accessions of *Lathyrus* species per year (Table 9). The total number of accessions distributed from 1992 through 1997, inclusive, is 4 578, with 503 of these distributed to countries in South Asia. Approximately 55% of the accessions distributed are of the three main species for which ICARDA has a improvement programme.

Table 9. Distribution of ICARDA *Lathyrus* germplasm

Year	All countries	South Asia	*L. sativus*	*L. cicera*	*L. ochrus*
1992	709	327	358	68	42
1993	741	0	342	144	120
1994	869	0	296	57	92
1995	102	118	73	9	17
1996	1 782	0	438	184	124
1997	375	0	98	18	27
Total	4 578	503	1 605	480	422

Table 10. Distribution of International nurseries of *Lathyrus* by ICARDA

Species	Trial	1994	1995	1996	1997
L. sativus	ILAT-LS	46	40	46	39
L. cicer	ILAT-LC	28	28	26	27
L. ochrus	ILAT-LO	27	28	29	20
Total		101	96	101	86

ICARDA has an International Nursery Network that distributes trials of *L. sativus*, *L. cicera* and *L. ochrus* in adaptation and yield nurseries. An average of 96 nurseries for these three species have been distributed yearly (Table 10). These trials provide a mechanism for distribution of improved germplasm to national programmes in WANA and worldwide from selection at ICARDA within germplasm and from populations developed through hybridization among improved types and germplasm accessions with important stress resistance/tolerance or quality traits.

Future research projections

Collecting activities in the future will be concentrated on targeted missions to fill gaps in geographical coverage of specific species and for important traits, such as disease resistance and cold tolerance. The breeding programme will mostly be based on selections from within populations developed through hybridization. In addition to work on the use of *Lathyrus* as a forage and feed crop, the ICARDA breeding programme will work on *L. sativus* as a food legume crop with a major emphasis on reducing ODAP content.

Genetic diversity research will be initiated in the three major species of *Lathyrus* (*L. sativus, L. cicera* and *L. ochrus*) with the objective to map the diversity that exists in the collection for these species. This will allow the identification of areas for possible *in situ* conservation. Also, this could be used to identify areas of high genetic diversity that are presently under-represented in the germplasm collections. Research will also be conducted using molecular markers to calculate the genetic similarities between the species of *Lathyrus* to determine the species that are most closely related to the three species of potential importance.

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Introduction, evaluation and utilization of *Lathyrus* germplasm in Australia

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Introduction

Traditional Australian farming practices were largely based on a ley-farming system consisting of cereal production rotated with a number of years of legume-based pastures which were grazed by livestock. In general, there were few adapted species or cultivars of pulse crops (grain legumes) suitable for Australian conditions, agronomic management of pulses was poor, pulse marketing was unsophisticated and the whole-farm benefits of growing pulses were undocumented. However, these factors were reversed during the 1970s and 1980s, and the emphasis of farming practices changed to one which was more cropping intensive and yet more sustainable by including pulses in rotations. Australian pulse production has increased rapidly as farmers appreciate the financial and rotational benefits, such as increased soil nitrogen and reduced disease incidence that pulses provide in the development of sustainable cropping systems. The area under pulse production has increased from effectively zero in 1965 to about 2.0 million ha in 1996, and pulses now occupy about 10% of the area cropped in Australia (Siddique and Sykes 1997). As might be expected from the geographical range of cropping environments in Australia (latitudes 10 - 44^{0}S), pulses are produced under a wide range of climatic conditions. Cool-season species such as lupin, chickpea, faba bean, lentil and vetch dominate the area and production of pulses in Australia. The current commercial cool-season pulse crops may not be suitable for every region or soil type in southern Australia and farmers may also require a range of pulse crops for their cropping rotations to reduce the build up of disease. This is where the potential of various *Lathyrus* spp. is of particular interest in Australia.

Early evaluation

Lathyrus spp. have been evaluated previously in Australia using a limited set of introduced genotypes. In two early studies, Riceman and Powrie (1952) and Bailey (1952) found that *L. sativus, L. cicera* and *L. ochrus* had good adaptation to the limited environments tested. Silsbury (1995) observed that *L. sativus* and *L. cicera* (one genotype each) were late flowering and had slow winter growth when compared with a local field pea cultivar. In a study with a limited set of genotypes, Laurence (1979) found that *Lathyrus* spp. yielded well in certain environments, especially in years with below-average rainfall. Walton and Trent (1988) also examined up to two genotypes each of three *Lathyrus* spp. at one site and found that *L. cicera* produced the greatest grain yields. A preliminary evaluation of a wider range of *L. cicera L. ochrus* and *L. sativus* from the International Centre for Agricultural Research in Dry Areas (ICARDA) found that they were all adapted to a site with 400 mm annual rainfall in Western Australia (WA) (Davies *et al.* 1993). The concentration of the neurotoxin ß-N-oxalyl-L-α, ß-diaminopropionic acid (ODAP) in the plant or seed is an important factor affecting the potential of *Lathyrus* spp. as a stockfeed and human food. However, it was not measured in any of the above studies.

Recent evaluation

In a recent study (Siddique *et al.* 1996a), the growth, phenology, grain yield and ODAP content of *L. sativus, L. cicera* and *L. ochrus* were compared with a locally adapted field pea cultivar to examine their potential in WA farming systems. About 17 genotypes of each species were obtained from ICARDA, Syria, and grown at three agro-climatical sites. In general, the species were later flowering than field pea, especially *L. cicera* and *L. ochrus.* However, *L. sativus* was the last species to mature. The best *Lathyrus* genotypes produced similar biomass near flowering to field pea. At the most favourable site, seed yields of 1.6, 2.6 and 1.7 t ha^{-1} were produced for *L. sativus. L. cicera* and *L. ochrus,* respectively compared with 3.1 t ha^{-1} for field pea.

The ODAP concentration in the seed was measured in the same study using the capillary zone electrophoresis method developed in Australia (Arentoft and Greirson 1995). There was considerable genotypic and environmental variation. On average over all the genotype evaluated, the ODAP concentration was lowest in *L. cicera* (0.13%), intermediate for *L. sativus* (0.33%) and highest in *L. ochrus* (0.66%). The study concluded that considering *Lathyrus* spp. have not had the same breeding effort as field pea and other pulses in Australia, further germplasm evaluation, selection and breeding is worthwhile. The authors also suggested that in short-seasoned Mediterranean-type environment of sourthern Australia, seed yields and harvest indices of *Lathyrus* spp. could be improved with early flowering and maturity, and emphasised the importance of reducing or eliminating ODAP in the plant and seed.

An assessment of wide range of *Lathyrus* germplasm was subsequently initiated. Accessions were obtained by the Centre for Legumes in Mediterranean Agriculture (CLIMA) from ICARDA, Bangladesh, Pakistan, Nepal and India including 454 of *L. sativus,* 127 of *L. cicera* and 55 of *L. ochrus* genotypes (Hanbury *et al.* 1995; Siddique *et al.* 1996b). Several genotypes of *L sativus* and *L. cicera* were identified with early flowering, good biomass production, large seed yield and ODAP concentration of less than 0.1 per cent. Many genotypes also produced similar or greater seed yield than field pea. In addition, 4 somaclonal genotypes of *L. sativus* with very low ODAP content (less than 0.02%) from India were recently evaluated, of which the best adapted genotype (BIO L254) was selected for further evaluation. *Lathyrus ochrus* genotypes were subsequently dropped from further evaluation due to high levels of ODAP in this species (Siddique *et al.* 1996a). Susceptibility of *L. ochrus* to frost damage is also likely to restrict its role in the dry margins of the cropping regions, while other pulse crops appear to be a more profitable in areas where rainfall is greater. Nonetheless, the vigorous growth and superior water-logging tolerance of *L. ochrus* suggests that its role as a forage crop or green manure crop should be investigated further.

Breeding and selection

Seventeen genotypes of *L. cicera* from the germplasm evaluation programme were assessed at 12 sites throughout Australia (WA, South Australia, Victoria and New South Wales) during the 1995 and 1996 seasons. Several accessions showed superior adaptation and greater seed yield than other genotypes at a number of locations, particularly at low rainfall sites (<400 mm p.a.). One such accession of *L. cicera* (ATC 80490) originating from ICARDA, produced similar seed yields to field pea in low rainfall environments. This accession has very low concentrations of ODAP in the seed (0.09%) and will be released for commercial production in early 1998 as a crop for low rainfall regions.

About 12 accessions of *L. sativus* were also tested at the same 12 locations in 1995 and 1996. *Lathyrus sativus* showed superior adaptation and seed yield to *L. cicera* at medium rainfall sites (>400 mm p.a.). Several genotypes produced greater seed yield than field pea at a number of sites. However, many of these had ODAP concentrations above 0.2 per cent. For example, the highest yielding accession (ATC 80092) had an ODAP concentration of 0.32 per cent making it unsuitable for commercial release. One Canadian genotype (LS 96278) had a consistently low ODAP concentration (0.13%), but it was poorly adapted due to its late flowering and maturity, and low seed yields at most sites.

The low ODAP somaclonal genotypes obtained from India showed lower yield potential than other accessions, and produced yields up to 1.3 t ha^{-1} at the best site. Three of these (BIO L254, BIO R202 and BIO R31) had mean ODAP concentrations of 0.06 - 0.07% over 3 sites in 1996. Because of the very low ODAP concentration, seed of the best adapted genotype (BIO L254) is currently being bulked up for possible release in the near future.

A small hybridization programme was initiated in 1994 with the objective of developing new cultivars of *L. sativus* with early vigour, zero or very low ODAP content, early maturity, erect canopy and large yield potential suitable for the Mediterranean-type environments of WA (Hanbury *et al.* 1995). Parents from ICARDA, Pakistan and Bangladesh with these traits were used for these crosses. Progenies are now in the F_4 generation and are currently being evaluated for desirable characteristics.

Uses of *Lathyrus*

Recent evaluation of introduced *Lathyrus* germplasm in Australia suggests that two species (*L. cicera* and *L. sativus*) are adapted to low to medium rainfall conditions of southern Australia. Both *Lathyrus* species show adaptation to a wide range of soil types (pH 5.0-9.0 in $CaCl_2$) and are tolerant to transient water-logging. *Lathyrus* could play an important role as a disease break crop for cereals and other pulse crops. For example, the inclusion of field pea in close rotations has resulted in an increase in the incidence of the disease black spot (*Mycosphaerella pinodes*), and yield decline after several cycles of field pea. Black spot disease does not affect *Lathyrus,* and no other major disease of *Lathyrus* has been observed in the last 5 seasons of evaluation in southern Australia. *Lathyrus* is seen as a possible replacement for field pea, or at least an opportunity to widen pea rotations.

Lathyrus will have diverse uses including forage production, grain for stockfeed and green manuring to improve soil fertility and control herbicide resistant weeds. As a grain or forage crop, there are also potential rotational benefits including increased yield and protein content of the following cereal crop. The greatest potential for *Lathyrus* within Australia is as a stockfeed both on and off farm. However, its feed value requires further quantification before it will be widely accepted by growers, or stockfreed companies. If suitable export food markets were to emerge, there is also scope to develop *L. sativus* genotypes with low ODAP for human consumption.

Conclusions

The future of *Lathyrus* as a crop in Australia, particularly *L. sativus,* will depend upon developing crop management packages for the various production environments, and regionally adapted, high yielding cultivars with very low or nil ODAP contents. Increased emphasis on early growth and greater final biomass production deserves further attention as a forage. Hay production, and green manuring are seen as some of the uses of *Lathyrus.* In addition to ODAP content, reduction in other antinutritional factors such as tannin and trypsin inhibitors may require greater attention. Management of major insect pests and diseases (as they arise) will be required in the major production areas.

In the future, primary, secondary and tertiary gene pools may contribute to the improvement of *Lathyrus* spp. The role of biotechnological approaches and interspecific hybridization techniques in reducing the ODAP content and improving biomass production and seed yield deserves greater attention. Well targeted germplasm introduction and evaluation, and identification of desirable traits are necessary to achieve the above objectives.

Recent collaboration on *Lathyrus* germplasm between CLIMA, ICARDA and various national programmes have benefited all parties involved. This has included identification and selection of *Lathyrus* genotypes for commercial release in Australia and collection mission on *Lathyrus* undertaken in Bangladesh, Pakistan, Nepal and a number of countries in West

Asia and North Africa. CLIMA also assisted Bangladesh, India and Pakistan in analysing ODAP concentrations in the seed of some advanced generation of *Lathyrus* spp. using the method developed in Australia. Further international collaboration should be encouraged.

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International collaboration on *Lathyrus* genepool conservation and use

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Introduction

This presentation is meant to complement IPGRI-APO in their contributions on the importance of establishing a *Lathyrus* Genetic Resources Network as a tool to achieve better conservation and use of this underutilized crop. It emphasizes in particular the role that such an international collaboration could play in enhancing food security in disadvantaged areas around the world where *Lathyrus* species are found to have a comparative advantage over other crops. The importance of *Lathyrus* in Central and West Asia and North Africa (CWANA) region is addressed while viewpoints for the implementation of the network are made with regard to the contribution that the West Asia and North Africa Plant Genetic Resources Network (WANANET) could provide as a partner in such scientific cooperation.

The WANANET

The West Asia and North Africa Plant Genetic Resources Network (WANANET) was established in 1992, during a workshop held at ICARDA Headquarters in Aleppo, Syria and sponsored by IPGRI, ICARDA and FAO. The meeting was attended by representatives from 13 countries (Algeria, Cyprus, Egypt, Iran, Jordan, Lebanon, Libya, Morocco, Pakistan, Syria, Tunisia, Turkey and Yemen) who endorsed the launching of this collaborative activity with the following overall objectives:

- Establish a regional network and formulate the type, mode of operation and management structure of the network.
- Identify common problems and constraints hampering effective conservation and utilization of plant genetic resources in member countries and in the region.
- Assist National Agricultural Research Systems (NARS) in developing national plant genetic resources programmes.
- Formulate and prioritize collaborative research work and strategies in collecting, conservation, documentation, germplasm exchange and training.
- Formulate recommendations for regional cooperative programmes in plant genetic resources.

The Network is governed by WANA Plant Genetic Resources Committee (WANA-PGRC) which is composed of national plant genetic resources coordinators in member countries and representatives of IPGRI, ICARDA and FAO. The Network operates through six Working Groups viz., cereals, horticultural crops, industrial crops, food legumes, *in situ* and biodiversity, pasture and forages. A Steering Committee assists the Working Groups to develop plans, formulate and monitor projects, assess priorities and identify potential donors.

WANA's interest on *Lathyrus*

Lathyrus genetic resources assume significant role in the countries of West Asia and North Africa. This region is a primary centre of diversity for *Lathyrus*, for example, out of the 187 *Lathyrus* species recorded around the world (Allkin *et al.* 1983) not less than 61 are found in Turkey alone (Davis 1970), 15 in Palestine and 10 in Jordan (Zohary 1972). Among the new *Lathyrus* species found in WANA is *L. gloeospermus* Warb. Et Eig, recorded from SE Anatolia in Turkey (Ertekin and Saya 1990). *Lathyrus* spp., like the WANA indigenous legumes *Vicia*, are being used in different cropping and land-use systems. Today *L. sativus* is the most commonly cultivated species of the genus in WANA and its use is mainly as source of feed and food in some traditional dishes. The minor uses of *Lathyrus* species from WANA are as green manure (e.g. *L. tingitanus* L. known as the Tangier pea), in perfumery (e.g. *L. tuberosus* known as the earth chestnut of which flowers are being distilled to prepare a scent) and as ornamentals (e.g. *L. odoratus*, the famous sweet pea cultivated since ancient times for its beauty and is popular among the Edwardians and used for scent extraction).

In Italy, a country not belonging to WANA but whose history has been always closely associated with people and traditions of the Mediterranean basin, *Lathyrus* is known in the southern region under various names and it is used in villages mainly as component of traditional soups (Hammer *et al.* 1992).

Lathyrus has interesting potential for WANA particularly with regard to:

- food security support in degraded marginal lands and in areas where agricultural inputs are not available or economically feasible.
- as drought resistant feed legume for contributing to increase livestock production in drought prone agricultural areas.
- as a specialty crop for enriching culinary preparations in mixture with other legumes and cereals.
- in maintaining ecosystem diversity in agricultural systems.
- in maintaining non-indigenous diversity in rangelands where it is not possible to have re-seeding with original vegetation and where *Lathyrus* species could well fit into a mixed vegetation system in harmony with existing ecosystem, and
- as a suitable species for food and feed adapted to environments under changing climatic conditions.

An international collaborative network would be welcomed by WANA countries which have a discrete number of activities going on and would be interested to be part of an international cooperative effort in the framework of the existing regional cooperation of WANANET. Since its establishment the WANANET gave particular emphasis to the better conservation and use of pasture, forages and rangeland species of the region and this is the reason why a specific Working Group on these species was established. The Working Group, which has met since its inception already three times, drew a set of recommendations in each meeting putting emphasis on *Lathyrus* as priority species for the region.

In these meetings the specific points that were made for enhancing *Lathyrus* conservation and use refer to the development of tools for a better characterization and evaluation of its diversity, namely:

- a descriptor list for a broad characterization and evaluation of pasture and forage species and
- a descriptor list for in-depth evaluation for pasture and forage species.

Other species that have been identified along with *Lathyrus* as priority for the WANA region are medics, vetch and *Trifolium*.

Apart from the above mentioned reasons, another important concern in WANA is the genetic erosion that *Lathyrus* species are facing in the Mediterranean (Hammer *et al.* 1992; Sabanci 1996). The loss of this useful crop diversity is due to more land use in intensive cultivation systems, overgrazing, unsustainable use of natural resources etc., but most of all neglect in its research which ultimately leads to its lesser use, abandoning of its cultivation by farmers and inevitably its disappearance.

Like many other neglected and underutilized species, the state of rarity or even extinction of a crop [see the case of the vegetable rampion, *Campanula rapunculus* L. lost by 1820 (Mabberley 1997)] could be reached without any evident sign, unless a monitoring system on use and diversity is put into place. Likewise the legume *Kerstingiella geocarpa* known as Hausa bean, a crop once very popular among the Hausa people in the savanna of Northern Nigeria has today almost disappeared from cultivation. In this case the conservation efforts carried out by the Nigerian plant genetic resources programme and by the International Institute of Tropical Agriculture (IITA) may not be enough if it is not accompanied by similar efforts in its improvement and use. In the case of another similar neglected African legume, *Vigna*, *subterranea* (bambara groundnut), an international network has been launched in 1996 to encourage conservation through use.

WANANET therefore lays emphasis on the preservation of *Lathyrus* diversity and at the same time encourages its better use through proper research.

Lathyrus network in IPGRI's overall strategy

IPGRI is in reprocess of developing an in-house strategy for neglected and underutlized species (NUC). This strategy is expected to guide IPGRI's work in this area which is at an infancy in terms of priority setting. The main reason why IPGRI is emphasising work on NUC is related to its ultimate institutional goal, shared with all the other CGIAR centers and which is the improvement of the life of people particularly in the less developed countries and in poorer areas around the world. IPGRI's strategy to meet this goal is through four objectives all of which rest on the premise that the deployment of plant genetic diversity in agriculture will lead to more balanced and sustainable patterns of development. By including the NUC, IPGRI's efforts are to increase the use of diversity within species, which are important in production and consumption systems but whose role is not officially recognized. *Lathyrus* is one of those species that fits perfectly in our strategy for achieving the ultimate goal of food security.

International collaboration on *Lathyrus*: some crucial issues

The proceedings of the 1995 meeting on *Lathyrus* (Arora *et al.* 1996) and the recently published *Lathyrus* monograph (Campbell 1997) clearly describe *Lathyrus* research, conservation and utilization. This is due to the accurate analyses made by the authors but also to the sound work done by scientists engaged in this field, particularly in Asia. The point of concern now is as to why we need a network approach on *Lathyrus.* A few critical issues related to the launching of such a cooperative research effort is discussed here.

Over 135 scientists from 93 institutions in 22 countries around the world are engaged at various level on *Lathyrus* work (Campbell 1997). The most cost-effective way to share benefits from these scattered efforts and have a multiplier effect of research output is through networking (Riley *et al*. 1996). Fundamental steps towards the establishment of the network are the identification of focal points in each region and institutions, an agreed working agenda in which specific tasks are spelled out together with the time frame necessary to accomplish them. Partnership rests upon the basic principle that single contributions have to be adequate to capacity and skills of each member. A realistic workplan in which each partner can give a concrete contribution is preferable to an ambitious research agenda in which only a few members can fully participate. This is a *modus operandi* that IPGRI has been adopting since the early 80s. There are also other reasons why IPGRI encourages such an approach and have to do with the fostering of collaboration among countries, along with germplasm sharing resources. It may be noted here that after the Rio Convention on Biological Diversity resulted in a slow down in exchange due to the reluctancy of countries and there is a need to promote cooperation in a *bona fidae* germplasm exchange system.

For example, the Ministry of Foreign Affairs in Italy when negotiating its support to IPGRI for the Underutilized Species of the Mediterranean (UMS) specifically stressed that one of the objective of such project was the promotion of greater scientific collaboration within the Mediterranean region. Being coordinator of two projects operating through networks, we would like at this point to highlight some issues that we perceive as the most crucial for achieving a truly effective Network.

Targeted species in the network: gene pool vs. crop diversity approach

The selection of the species on which to focus the attention of the network is always a crucial decision at the onset on any Network. Such decision of course depends on the resources available and the geographic area covered by the network. The broader is the network the greater is the diversity expected to be taken into consideration by the network. In the case of the UMS Project, the Rocket Genetic Resources Network decided to concentrate the attention on those most used species viz., *Eruca sativa, Diplotaxis muralis* and *D. tenuifolia* excluding other species such as *D. erucoides* which is not used very widesly. In the case of the *Beta* Genetic Resources Network, all *Beta* species are being addressed by the Network participants, and a similar approach has been taken for *Prunus* and *Brassica* Networks of the European Cooperative Programme on Plant Genetic Resources (ECP/GR).

Our suggestion would be to adopt the genepool approach for *Lathyrus*, which focus the attention on all those cultivated species grown in the various regions as well as their wild relatives. Since it may not be possible to define the boundary of the primary, secondary or tertiary genepools for each cultigen, we could perhaps leave a broad coverage now and revise the prioritization pending the delimitation of the genepool boundary at a later stage. Pillars of the conservation approach for *Lathyrus* would be the development of on-farm conservation as a complementary tool to *ex situ* conservation while strengthening the support for the use of genetic diversity in production and use systems. Ways to assess the representativeness of germplasm collections and monitor genetic erosion would be a very important task of the *Lathyrus* network and due to the scarce information we have for a number of countries on this issue, the characterization, mapping of distribution of these species would be extremely vital.

Participation

This is another crucial aspect. We would encourage the identification of focal points in each country who will be responsible for representing the whole national scientific community working on *Lathyrus*. We will discuss on the financial resources needed for the networking, but I do not think that it would be enough to enable the participation of more than one person per country. Depending where the meetings will be held we may have a larger participation from local scientists at their own cost. This approach would of course save money that could be used for research activities instead.

Role of the hub

It should be understandable that given the magnitude and the scope of such a cooperation, the Network coordinator that will be identified will have limited capacities and will largely count on the spirit of cooperation within the Group. The coordinator can only play the role of a facilitator serving as a secretariat for the Network. Given the comparative advantage of IPGRI in the international plant genetic resources context, we would encourage the IPGRI-APO Office in New Delhi to play such role.

Country commitment

This is crucial for carrying out the agreed workplan. Role of the country focal point is to seek support, establish links with other groups/experts in various organizations within the country to undertake the tasks and possibly to cover costs associated with such work. The question is obviously what is the actual possibility in each country to take up this commitment and what will it be exactly. Addressing this issue while bearing in mind the importance of safeguarding germplasm and traditional knowledge associated with it, it should be stressed that among the countries commitments perhaps the most important and relatively costly one is that of collecting and preserving *Lathyrus* genetic diversity. The impact of networking for encouraging these activities in each country is perhaps the most dramatic one. Networking would/should stimulate focal points in raising the awareness in their own country on *Lathyrus* and hopefully indirectly promote other NUC species through such an example of international cooperation.

Germplasm exchange

This is a very sensitive issue in the aftermath of the Biodiversity Convention, but it is understood that an effective cooperation on *Lathyrus* needs to rely on the sharing of material to be able to carry out trials in various countries and ultimately provide to the farmers the product of such work. IPGRI considers networking as one of the most effective way to facilitate sharing of plant genetic resources around the world and thus meet the ultimate goals which are to fight hunger and improve quality of life. The possibility to adopt a specific approach (like the agreement being put into place by the CGIAR for collections under their trust) on plant genetic resources exchange can be eventually decided by the network members.

Workshops and meetings

It would be very sensible to arrange every two years a conference on *Lathyrus* and the network meeting. This is the approach taken by the *Beta* Network which is perhaps the closest type of network to *Lathyrus*. The *Beta* Network has been receiving a small grant from IPGRI every two years for covering the cost of the conference proceedings whereas support from private companies has been used to cover conference costs. External support from private groups might be less likely for *Lathyrus* given the importance of the crop, but grants from international development organizations could perhaps be sought as alternative source of funds. It is also suggested that the biennial meeting be held every time at a different location in one of the participating country in the network. The convening country should also try to involve other scientists working at the national level on this subject in order to achieve a wide public awareness campaign on the network itself, while creating the opportunities for a greater interaction and exchange of ideas within the scientific community working on this crop. Certainly, the WANA office would welcome the possibility to arrange a *Lathyrus* Network conference in the WANA region sometime in the near future, which could be held back to back to a WANANET Forage and Pasture WG meeting.

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Databases and information networking for *Lathyrus* genetic resources

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Introduction

The conservation and sustainable utilization of plant genetic resources is the key to improving agricultural productivity and sustainability thereby contributing to national development, food security and poverty alleviation. Plant Genetic Resources for Food and Agriculture (PGRFA) consists of the diversity of genetic material contained in traditional varieties and modern cultivars grown by farmers as well as crop wild relatives and other wild plant species that can be used for food, feed for domestic animals, fiber, clothing, shelter, wood, timber, energy, etc. One of the major challenges we face in moving towards food security in the next generation is the effective management of plant genetic resources worldwide. In this context, plant genetic resources databases are very important at national, regional and global levels to back up conservation of rapidly disappearing genetic stocks for possible future use and also for immediate utilization of already conserved and evaluated/ characterized germplasm in the ongoing crop improvement programmes. Success of both activities is, to a larger extent, dependent upon the availability of descriptive information on accessions stored in the genebank. There is also a need for an efficient characterization, evaluation and documentation of plant genetic resources to avoid any legal complications arising out in the wake of Intellectual Property Rights (IPR), at the same time there is a need for monitoring and controlling of factors leading to genetic erosion.

Need for PGR documentation system

It is now widely recognised that in order to strengthen the conservation and to enhance its utilization, there is a strong need for the development of better and more accessible information and documentation systems. Documentation skills are essential resources for any genebank. Genebanks will have problems managing their collections if they do not have up to-date, accurate and reliable information stored in a systematic and easily accessible way. Much of the information acquired and generated by a genebank is of interest and of value to the scientific community. Genebanks commonly distribute their accessions together with relevant information. However, not all information generated in genebank activities is of interest to other scientists but is of vital importance in its own activities and managing resources. A documentation system will therefore allow genebanks to use information to plan their day to day activities and to maximise the use of their often-limited resources. Also, without an effective documentation system, genebanks cannot develop with a clear sense of direction and they can not easily communicate or collaborate with other institutions.

Further, genebanks differ from one another according to their activities and how the activities are organised. Since documentation systems support all these activities, it follows that the documentation systems operated by separate genebanks will also be different. Many genebank documentation systems do show some similarity in design and operation, but each will be different, as they are tailored-made according to the documentation and information needs of the genebanks. In any case, the information retrieved from a documentation system must be accurate, reliable and up to-date for it to be of any significant value which is turn depends on the quality of information entered into the system. Additionally, the process of retrieving information should be simple and straightforward. The documentation system should be flexible in its operation. It should be able to cope with different requests for information and be able to accommodate changes in genebank procedures. Therefore, in a documentation system, users needs must be taken into account when organising data.

Lathyrus documentation activities at IPGRI-APO

It is well recognized that many of the world's *Lathyrus* genetic resources are insufficiently and/or poorly documented relatively to what should be known about them for its optimal conservation, access and use. This situation is exacerbated due to fact that *Lathyrus* genetic resources conservation and use is given low priority at national and institutional level in general and its database management and documentation activities in particular, both in terms of funding and manpower.

Realising the importance of documentation of *Lathyrus* genetic resources, IPGRI-APO has initiated the following activities:

1. Development of descriptors for *Lathyrus* species.
2. Directory of *Lathyrus* germplasm holding and researchers.
3. Information Networking for *Lathyrus* genetic resources.

Development of descriptors for *Lathyrus* species

The process of characterization and evaluation begins with the adoption of descriptor list. Depending on the circumstances, it may be compiled by the national organization, collection manager, or an existing list might be adopted. The IBPGR/IPGRI descriptor lists are quite exhaustive and are, by and large, widely used by the PGR scientists. IPGRI encourages the collection of data for passport, management, environment and site, and characterization descriptors. However, the number of descriptor types used will depend on the crop and their importance to the crop description. Descriptors listed under evaluation allow for more detailed description of the accession's characters, but generally require replicated trials.

IPGRI descriptor lists have tended to be comprehensive for the descriptors. This approach assists with the standardization of descriptor definitions. IPGRI does not, however, assume that each curator will characterize accessions of their collections utilizing all descriptors given. Descriptors should be used when they are useful to the curator for the management and maintaince of the collection and/or to users of the plant genetic resources. Descriptors for 79 agri-horticultural crops have already been published by the IBPGR/IPGRI and many more are under preparation including one for *Lathyrus*.

Directory of *Lathyrus* germplasm holdings and researchers

IPGRI-APO organized a Regional Workshop on *Lathyrus* Genetic Resources in Asia in collaboration with Indian Council of Agricultural Research/Indira Gandhi Agricultural University at Raipur from 27-29 December 1995. The workshop was attended by 25 scientists/managers involved in *Lathyrus* improvement representing Australia, Bangladesh, India, Jordan, Nepal, Turkey and from IARC's viz. IPGRI, ICARDA and ICRISAT. One of the major recommendations of the workshop was to prepare a Directory of *Lathyrus* genetic resources available with different organizations/institutes. Publication of such directory will be very useful for the information exchange as well as for exchange of germplasm among scientists working on *Lathyrus* improvement. This will also help in developing low level network for promoting *Lathyrus* conservation and improvement. As a follow up of the recommendations of the Regional Workshop, IPGRI-APO has undertaken publication of *Lathyrus* germplasm directory. Accordingly, the following Performa was developed and was circulated to more than 125 institutions in 46 countries. The information received are being compiled and the directory will be published soon for wider circulation.

Performa for collecting information for *Lathyrus* germplasm directory

Name of Institute/Center/Station

Full name and address of the institute(s) maintaining the collections alongwith their Telephone, Fax, Cable, Telex, E-mail addresses, etc.

Curator/Person in-charge (capitalised surname if any)

Details of collection

- Record of individual *Lathyrus* species collections maintained at your center.
- Geographical representation.
- Duplicate conservation site(s).
- Number of indigenous collection.
- Frequency table showing number of indigenous accessions by province/state of collection.
- Number of exotic collections.
- Frequency table showing number of exotic accessions by country of introduction/ origin.
- Future priority areas for collecting for each species in your country/region.
- If possible, a country map showing areas already explored and collected and areas under threat requiring urgent collecting.

Passport information

- List of most common passport descriptors for which informations are available.
- Full name and address of donor institutes, wherever possible.

Characterization and evaluation information

Evaluation status

What is the status of evaluation? If evaluated/or being evaluated, what descriptors are being used? Any further information on specific evaluation may be given.

Site of characterization

This includes information on Name of the institute(s), Latitude, Longitude, Elevation, Soil texture, Normal sowing month, Normal harvest month, Field spacing (distance between plants and between rows), Average climate during growing season (temperature range, rainfall range, sunshine hours etc.), any other site-specific information.

Documentation information

Are the data recorded being documented and made available to users? If so, documentation methods used and how the information is being made available to users (e.g. crop germplasm catalogues, computer print out, electronic format, Internet, etc.)?

Identification of promising accessions

List of promising accessions identified for various descriptors, which are of direct importance to users/plant breeders.

Information on utilization of genetic resources

Do you keep track of/or get a feedback on the utilization of germplasm by plant breeders for developing improved cultivars in the country? If so:

- Cultivars released for general cultivation.
- Cultivars released exclusively for high seed yield.
- Cultivars released exclusively for fodder yield.
- Cultivars released with low ODAP content.

Seed conservation/regeneration information

- Responsibility for conservation/maintenance (name of institute/genebank).
- Maintenance of collection (Base, Active and/or Working) and duration of storage.
- Moisture content at harvest.
- Moisture content at storage.
- Germination at storage (%).
- Amount of seed of each accession normally kept for storage.
- How frequently you need to regenerate the collection and reason for regeneration?
- Total number of indents received for seed supply each year and number of samples supplied (information for past five years).

Availability of germplasm

Are the collections available for free exchange?

Quarantine regulation

Are there specific permits etc., required for germplasm exchange? If so, provide details/ procedures to obtain such permits.

Lathyrus species reported from your country/region

Some general information

- Area under cultivation.
- Average production (t ha^{-1}).
- Uses (Current/potential).
- Area under cultivation with local landraces.
- Area under cultivation with improved released cultivars.

Name and addresses of contact persons

Provide full names and addresses (including Telephone, Fax and Email) of scientists/ managers who are directly or indirectly involved in conservation and improvement of *Lathyrus* in your country.

Any other information

Information networking for *Lathyrus* genetic resources databases

Individuals and organizations have been coming together to collaborate and to share information and resources for a very long time. And such groups have been termed “Networks”. Well over 100 agricultural research networks are now operating (Riley 1993). These networks are seen as tools for more efficient and cost-effective methods to carry out mutually beneficial activity, e.g., information exchange and research.

A common activity in Plant genetic Resources (PGR) Networks involves establishing information network on a national and/or regional level. Information networking was recognised as an important component of a viable and effective PGR management in the region (Quek 1993). This is in line with the Convention on Biological Diversity (CBD) and this enables information and/or PGR materials to be shared within and among countries. In most instances, PGR information is available in genebanks. It is essential that genebanks participating in Information Networks have proper documentation and available information for dissemination, to avoid problems of under-utilization of accumulated collections of germplasm held in many genebanks and research centres.

As indicated earlier, PGR documentation and information system usually gets low priority and figure only after collecting, characterization and evaluation of an accession. For a strong

PGR programme, all available germplasm accessions must be documented and the information must be available to the end users. Failing this, all the PGR materials collected, characterized and evaluated would be either used only by the concerned institutes where the PGR are maintained or, in some cases, not even by the researchers of the same institute as they have no information about the desired traits available in the collection.

Information networking involves the process of making the national programmes (NPs) ready for information exchange and then the exchange of information. Our experience shows that NPs are reluctant to change their existing system, mainly due to lack of resources. Therefore, the approach in APO is to develop an easy-to-use format for exchange of data among genebanks using their existing system. The Data Interchange Protocol (DIP) is one such tool developed to facilitate exchange of information between the genebanks irrespective of systems used, developing electronic germplasm catalogues/directories, developing database of PGR scientists/researchers etc. Efforts are also under way to link databases with visual analysis tools like Geographical Information System (GIS) and Regeneration Decision Support System, analytical tools like statistical software and data mining.

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Utilization of *Lathyrus*

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Introduction

Khesari (*Lathyrus sativus* L.) is cultivated in a number of countries for human food, animal feed and fodder. The crop is well adapted to the rice ecosystem as it tolerates flooding at early stages and drought later in the season. Therefore, it makes a valuable contribution to the sustainability of the rice production system especially in South Asia. In the absence of *Lathyrus* or a similarly adapted crop much of the land following rice remains fallow.

Rotter *et al.* (1991) reported chemical composition of four samples of *Lathyrus* which show it to be very high in its protein content. *Lathyrus* also shows a higher level of trypsin inhibitor activity (Campbell 1997).

Lathyrus is infamous for a neurotoxin ß-N-oxalyl anino alanine (BOAA) or (ODAP) which is associated with paralysis (lathyrism), a motor neuron disease of lower limbs in human beings. This disorder may result from the use of *Lathyrus* as a staple food for three or more months. However, reduction of ODAP through cooking, processing and by genetic detoxification (breeding varieties with low toxin content) has been possible (Mehta 1997).

The major uses of *Lathyrus* include, green fodder, use as a pasture, dried stover, seed as feed and as human food. In South Asia, Ethiopia and China the crop is dual purpose and in other regions it is mostly used as fodder and feed. There is some information that the toxin content in *Lathyrus* is increased in drought conditions and in zinc deficient soils. More studies are required to investigate these relationships. In this paper uses of *Lathyrus* in major producing countries are discussed briefly.

Uses of *Lathyrus*

Ethiopia

In Ethiopia, *Lathyrus* is eaten in different ways (Tekle-Haimanot *et al.* 1995). Boiled *Lathyrus* seed (*nifro*) is often eaten. This preparation is not considered harmful as much of the toxin is destroyed. Unleavened bread (*kitta*) is used in times of acute food shortage. Roasted grains (*Kollo*) are used as snacks. *Kitta* and *Kollo* preparations do not destroy much of the toxin.

Shiro is a flour prepared from legumes including *Lathyrus* and is used in making *Wott,* an Ethiopian sauce. The pan-cake like unleavened bread - *enjera,* made out of teff, wheat, barley, maize or sorghum is eaten with *Wott.* Role of *Wott* in lathyrism is not known.

India, Pakistan, Bangladesh and Nepal

The most common use of *Lathyrus* is as *dhal.* Some people soak the seeds or *dhal* overnight and decant the water before cooking. This system of preparation eliminates about 90% of the toxin. Nearly 10% of the *dhal* is used mainly for culinary purposes. More than 90% of *dhal* from the Madhya Pradesh state of India is sold to other states. The preparations from *Lathyrus besan* appear to be similar to those from chickpea *besan.* These include *pakoras, piazu, chapati, dhal, vadi, dhokla* and sweets. Therefore, substantial *Lathyrus* flour is used to adulterate chickpea *besan. Lathyrus dhal* is also mixed with pigeonpea *dhal* (Pandey and Kashyap 1995). This has reduced chances of lathyrism. Although the consumer pays relatively high price for *besan* this does not benefit the farmer as sale of *Lathyrus* is banned in some places.

The use of *Lathyrus* as leafy vegetable, green pods, green seeds as snacks or as cooked vegetable is also common and appear to have less contribution in causing lathyrism. Snacks made out of *Lathyrus* are noted for their taste. It was suggesed from Bangladesh that use of Vitamin C rich foods alongwith *Lathyrus* reduces chances of lathyrism.

China

Lathyrus is used as animal feed and as a supplement in food processing in Shaanxi and Gansu provinces. Farmers prefer it because of 20% higher yield and more stable production than pea (Zhou and Arora 1996).

Turkey

Lathyrus species are tolerant to cold, water logging and drought. The green fodder yields were up to 27 t ha^{-1}, dry fodder 8 t ha^{-1} and seed yield 2.5 t ha^{-1}. Among all *Lathyrus* species, *L. sativus* appears to be the highest producer of biomass and grain. Therefore, the species is ideal for feeding the cattle and is preferred by the farmers.

Animal feed and forage

Green leaves and stems of *Lathyrus* are fed to lactating cattle (because of phyto-estrogens) or the crop is strip grazed by the cattle and allowed to regrow for seed harvest. The use of dried stem and chaff after the grain is winnowed is often the most important factor in growing this crop in parts of Asia. The fodder is used in lean dry season as a protein rich fodder. Nearly 60% of the crop is used for forage and about 60% of the seed is used for animal feed in the Sind province of Pakistan (Campbell 1997).

Briggs *et al.* (1995) reported that up to 20% *Lathyrus* in pig feed was acceptable for commercial use in Canada. *Lathyrus* as animal and poultry feed is also being experimented in Europe, Australia and the middle East.

Conclusion

Lathyrus sativus remains an important food and feed crop in some parts of the world despite being known as causal agent for lathyrism. Its use as a relay crop and its tolerance to flooding and drought has no competing crop in rice-fallows. Efforts are underway to understand the toxin and genetic detoxification to develop low toxin lines which pose less threat to human and cattle health. Considerable successes have been achieved in this direction recently in Canada, India and Bangladesh, especially through support from IDRC and IPGRI. While the seed of these new varieties may take time to spread, efforts should continue to find ways for safe consumption of this high protein pulse crop and its use for enhancing sustainability of the rice-based systems.

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Biochemistry of the *Lathyrus* toxins

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The toxin believed to be the cause of human neurolathyrism was isolated and characterised independently by two groups as β-N-oxalyl-L-α, β-diaminopropionic acid (ODAP) (Rao *et al.* 1964; Murti *et al.* 1964). The biosynthesis of this neurotoxin was proposed by Malathi and co-workers to be derived from free diaminopropionic acid and oxalyl-Coenzyme A (Malathi *et al.* 1970). For the origin of diaminopropionic acid no explanation was formulated, and the compound as such was never identified in *Lathyrus* species.

Independently from this work, we found a group of eight heterocyclic isoxazolin-5-one derivatives in the seedlings of garden pea (*Pisum sativum*) and sweet pea (*Lathyrus odoratus*) (Lambein *et al.* 1969 ; Lambian and Parijs 1974). This was a new heterocyclic ring for natural products; the identity of the ring was proved very high sensitivity to ultraviolet light. The breakdown products of these compounds included the known *Lathyrus* toxins β-aminopropionitrile (BAPN), the osteotoxin of *Lathyrus odoratus*; a, γ-diaminobutyric acid (DABA), the neurotoxin of *L. sylvestris,* and L-α, β-diaminopropionic acid. This observation suggested a link between the group of isoxazolinon derivatives and the *Lathyrus* toxins. Much later we could confirm that one of these compounds, β-(isoxazolin-5-on-2-yl)-L-alanine (BIA), is the biosynthetic precursor of the neurotoxin ODAP (β-N-oxalyl-α, β-diaminopropionic acid) in *L. sativus* (Lambein *et al.* 1990, Kuo and Lambein 1991, Kuo *et al.* 1994a, Kuo *et al.* 1994b). BIA was formed from the free ring and O-acetyl-serine by casteine synthase in *L. sativus* (Ikegami *el al.* 1993). Recent studies showed that BIA (0.5-2.0 mM) itself also produced a concentration-dependent neurodegeneration in mouse cortical explants (Riepe *et al.* 1995). This excitotoxic effect was mediated by non-NMDA type receptors similar to the action of ODAP but to a much lesser degree. In another recent report, BIA was found to be inactive in the NDMA receptor binding assay in rat brain, while ODAP exhibited an inhibitory activity at a relatively high concentration (IC_{50} : 47 mM) (Ikegami *et al.* 1995). BIA was found to be exuded by the roots of *Pisum sativum* and *Lathyrus odoratus* (Kuo *et al.* 1982) and besides neurotoxic effect on the mammalian cells if acted as a potent growth inhibitor of several eukaryotic organisms including yeasts phytopathogenic fungi, unicellular green algae and higher plants (Schenk 1991). Its broad antifungal activity suggested that BIA might play a role as allelochemical.

Considering the biological and ecological importance of BIA, the metabolism of this compound was studied in *L. sativus* and in *L. odoratus.* Radioactive [^{14}C]-labelled BIA was obtained from *in vivo* labelling experiments with *Pisum sativum* seedlings, after feeding [U-^{14}C] serine to the imbibing seeds. [^{14}C]-labelled BIA was extracted from 2-day-old seedlings, purified and used for this study. Radioactive [^{14}C] BIA was added to imbibing seeds of *Lathyrus sativus,* and the seeds were allowed to germinate during two days. After extraction of the two-day-old seedlings, we found that ODAP and also the γ-glutamyl derivative of BIA, designated as compound XI (Lambein *et al.* 1992), were both labelled in the cotyledons and in the embryo.

When the same radioactive BIA feeding experiment was carried out with *L. odoratus,* we found that compound V, 2-(γ-glutamyl-aminoethyl)-isoxazolin-5-one was labelled (Lambein and Parijs 1974). Structurally compound V is the decarboxylation product of XI. Although compound XI is not normally found in *L. odoratus,* it can well be the short-lived precursor of compound V, like α, β-diaminopropionic acid (DAPRO) is the short-lived precursor of

ODAP (Kuo and Lambien 1991). Therefore [^{14}C]-labelled XI, purified from 2 day-old-seedlings of *L. sativus* by feeding [U-^{14}C] serine to imbibed seeds, was fed to the seeds of *L. odoratus.* The results showed that compound V is labelled and this confirmed that compound XI might be the short-lived intermediate between BIA and V in *L. odoratus.*

From the above experiments we can conclude that in *L. sativus* seedling BIA is metabolised to ODAP and to XI, while in *L. odoratus* seedlings BIA is metabilised to V via XI as intermediate, and not to ODAP (Fig. 1). An alternative way to reduce the neurotoxin ODAP in *L. sativus* might be the introduction of the gene in *L. odoratus* responsible for the biosynthesis of V into *L. sativus* plants and withdraw the molecules of BIA from the pathway leading to ODAP (Kuo *et al.* 1998).

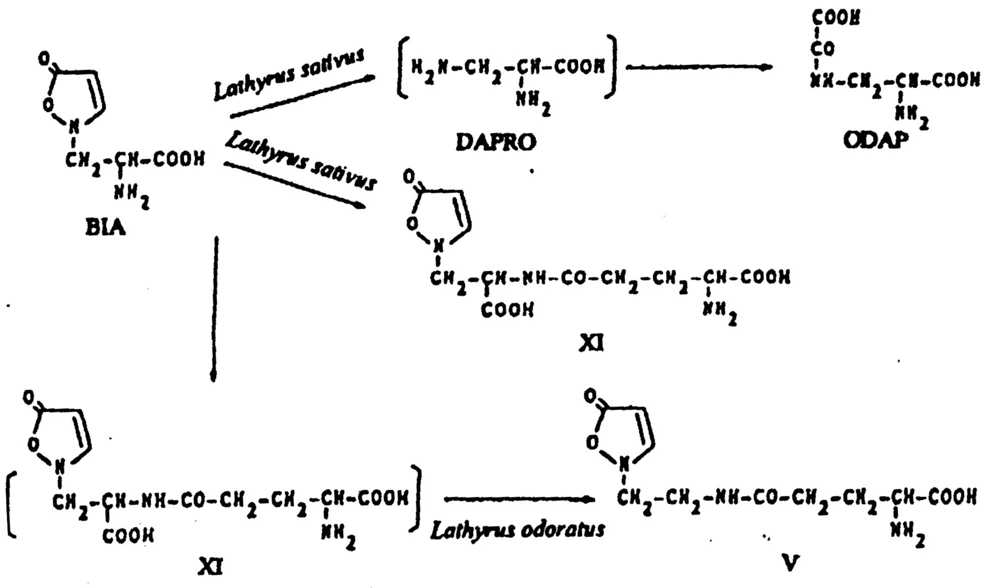

Fig. 1. Metabolism of BIA, β-(isoxazolin-5-on-2-yl)-L-alanine, in *Lathyrus* sativus and *L. adoratus* seedlings. Brackets indicate that compound DAPRO (α,β-diaminopropionic acid) and compound XI (γ-glutaMyl derivative of BIA) were not detected in *L. sativus* and in *L. odoratus* seedlings, respectively, but are considered to be short-lived intermediates.

The level of ODAP in the seeds of *Lathyrus sativus* is very variable, due to the high variability of the species, and high levels of ODAP are generally blamed for the occurrence of human lathyrism. Since the identification of ODAP as a neurotoxin present in the seeds of *L. sativus,* major efforts have been undertaken to select low toxin lines by traditional breeding and selection, and also by the production of somaclones. The main focus of this research was the level of ODAP. When other amino acids in the seeds are studied, we found that the level of homoarginine, an inhibitor of nitric oxide biosynthesis occurring in the seeds at levels to those of ODAP, is unaffected by the level of ODAP. In a series of somaclones isolated by Patil and co-workers (Patil *et al.* 1997), we found a variation in ODAP content of a factor 10, while the homoarginine levels varied with a factor of 3 only. In a preliminary report, Yusuf and co-workers proposed a protective potential of homoarginine against the toxicity of ODAP in chicks (Yusuf *et al.* 1995). If this is confirmed, then the real toxicity of *L. sativus* seeds may be combination of several factors rather than only the level of ODAP.

Considering the rather erratic distribution of human neurolathyrism in the countries where *L. sativus* is consumed, it may be worthwhile to look not only at the genetic variability, but also at the impact of environmental changes on the toxin level. During our studies on the biosynthesis *in vitro* of ODAP, we had noticed that the biosynthetic activity of both the low toxin and the high toxin varieties was rather similar. When some environmental effects such as drought stress were studied, it was found that the level of ODAP increased under drought conditions in hydrophonic cultures, or could decrease by irrigation in the field. Occurrences of epidemics of human lathyrism often coincide with a famine that was the consequence of a period of crop failures due to drought or to other environmental disasters. Unfortunately, the *Lathyrus* seeds consumed during such periods are not availabe for analysis. From epidemiological surveys it can be suggested that there is a link between the agro-ecological conditions and the incidence of lathyrism (Lambein and Kuo 1997).

In Ethiopia as well as in Bangladesh, the highest incidence of neurolathyrism is localised in areas where the land is flooded during the rainy season and a subsequent drought seems to increase the incidence of lathyrism. On the other hand, at the coastal areas of Bangladesh no lathyrism occurs while the consumption is not drastically different from the rest of the country.

Hussain and co-workers studied the effect of several environmental factors on the level of ODAP and other amino acids, and observed that *L. sativus* demonstrates a relative tolerance to salinity, and that an optimal concentration of salt has an increasing effect on the yield, while at the same time the level of ODAP is minimal (Hussain *et al.* 1997). Under the same conditions of salinity, the level of homoarginine shows a drastic increase (Hoque *et al.* unpublished).

Environment effects due to the presence of heavy metals in the soil may also be a factor in the etiology of lathyrism, because contamination with cadmium not only gives an important increase in the level of ODAP in the seeds of *L. sativus,* the toxic cadmium also accumulates in the seeds (Hussain *et al.* 1997).

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Utilization of genetic resources in *Lathyrus*

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Introduction

Lathyrus sativus is one of the most ancient crops used by man in Asia, Africa, Europe and South America for a multitude of purposes. The cultivated area under this crop is declining and diversity of landraces is being eroded. Being very hardy crop, a cheap source of protein to poor people and a good quality fodder, it is still being preferred by the farmers of dryland areas inspite of discouragement. It has a promising future as a model crop for sustainable agriculture, if the problems posed by the toxic compound (ODAP) can be solved.

In India, its cultivation is mainly confined to the states of Madhya Pradesh, Bihar, West Bengal and Maharashtra but is also grown in small pockets in other states. The most common farming system is relay or *Utera* under which its cultivation is most prevalent in India. Under this system, farmers give more emphasis for its fodder value and consider grain yield as bonus.

For collecting the *Lathyrus* diversity in India, a joint effort was made by Pulses Improvement Project of USAID, New Delhi; National Institute of Nutrition (NIN), Hyderabad and Directorate of Agriculture and Directorate of Health, Government of Madhya Pradesh in 1967 to collect *Lathyrus* germplasm from seven districts of Madhya Pradesh. Later, in 1969, under PL 480 project at the Indian Agricultural Research Institute (IARI), New Delhi, germplasm was collected from Bihar, West Bengal, eastern Uttar Pradesh, Gujarat and Haryana and was subsequently evaluated.

Germplasm evaluation

Genetic variability

For genetic improvement, an assesment of the variability in the germplasm is essential to judge its potential as base material. Two hundred and eight accessions of *Lathyrus sativus* were evaluated at Indian Institute of Pulses Research (IIPR), Kanpur during *Rabi* 1994-95 in an augmented block design using two checks, viz., Pusa 24 and LSD 3. The variability parameters for six quantitative characters, viz., plant height, number of primary branches, pods per plant, seeds per pod, 100-seed mass and grain yield were estimated (Table 1).

Phenotypic coefficient of variation was highest for pods per plant (39%) followed by grain yield (38%) and 100-seed mass (33%). A considerable level of variability for these characters has been reported by Vedna Kumari and Mehra (1989). These characters can therefore, be directly utilized in the genetic improvement programmes. The other characters like number of primary branches, plant height and seeds per pod showed comparatively

Table 1. Estimates of variability parameters for six characters in *Lathyrus sativus*

Character	Mean	Range		C.V. (%)
		Maximum	Minimum	
Plant height (cm)	33.75	14.0	59.0	21.01
No. of primary branches	3.90	2.0	6.0	21.28
Pods/plant	25.67	6.0	62.0	39.46
Seeds/pod	2.42	1.3	3.3	16.52
Grain yield (g)	3.89	1.0	8.8	38.56
100-seed mass (g)	6.92	4.5	15.7	32.94

lower levels of variability. However, it would be worthwhile to examine the association of these characters with grain yield in order to utilize them in the breeding programme.

Association studies

Pods per plant, plant height and 100-seed mass displayed a significant positive correlation with grain yield (Table 2). These results are in agreement with those of Kaul *et al.* (1982) and Karup (1983). An indirect selection through these characters may be effective in *Lathyrus* improvement programme.

Table 2. Correlation coefficient for six quantitative characters in *Lathyrus sativus*

Character	No. of primary branches	Pods/ plant	Seeds/ pod	Grain yield	100-seed mass
Plant height	0.256**	0.271**	0.077	0.487**	0.330**
No. of primary branches	0.504**	-0.062	0.490**	0.092	
Pods/plant			-0.224*	0.686**	-0.063
Seeds/pod				0.026	-0.193
Grain yield					0.277**

* Significant at 5% level of probability; ** Significant at 1% level of probability.

Divergence analysis

Forty six germplasm lines, including 15 exotic collections, of *Lathyrus sativus* were evaluated for ten characters to study the genetic divergence. The genotypes were grouped into eight clusters. Days to maturity and 100-seed mass were found to be the important contributors toward genetic divergence. Genetic diversity did not appear to be associated with geographical distribution of the genotypes.

Varietal development

Plant breeding efforts during last three decades have led to the development of certain low ODAP genotypes. Pusa 24, a selection from germplasm, was the first variety identified in 1974 with relatively low amount of ODAP (0.2%) and suitable for upland cultivation (Jain *et al.* 1994). Another variety, Nirmal was also selection from local germplasm with ODAP content 0.2% and released in 1980 in West Bengal. Later on, some other genotypes like LSD 1, LSD 3 and LSD 6 were developed with ODAP around 0.2%. Most of the genotypes developed earlier were selections from germplasm (Table 3).

During the last few years, some cultivars have been developed with good yield potential and ODAP below 0.2% (Table 4). Recent, development of some somaclones with low ODAP (<0.1%) has opened a new avenue in *Lathyrus* improvement. These are Bio L 212, Bio R 202, Bio L 203, Bio R 231, Bio L 208 and Bio I 222. The variety Bio L 212 was released in 1997 as low ODAP variety with good yield potential.

At IIPR, Kanpur some of the promising crosses involving low ODAP genotypes are in advance generation. The low ODAP donors currently being used in our programme are Bio R 202, Bio L 212, Bio L 203, Bio R 231, Bio L 208, P 94-3, P 28, L5 8246 and Bio I 222.

Male sterility

Male sterility has been reported in *Lathyrus sativus* by Srivastava and Somayajulu (1981) which is conditioned by a recessive gene ms_1. Also, the Gene-Cytoplasmic Male Sterility system had been reported by Chekalin (1972) and Zelenskaya and Pestova (1974) wherein the male sterility is due to the interaction of two *fr* genes and S-cytoplasm. It is possible to use this male sterility system in population improvement programmes and to exploit some of the non-additive gene action on characters affecting grain and forage yield.

Table 3. Pedigree of *Lathyrus* varieties/genotypes

Varieties/Genotypes	Pedigree
P 24	Selection from *utera* crop field collection from Bihar in 1966
LSD 1	Selection from P 24 (P 24-1) in 1978
LSD 3	Selection from P 24 (P 24-4-1B) in 1978
LSD 6	Selection from P 24 (P24-2-C) in 1978
Sel. 505	Selection from Santhal-Pargana district in 1979-80
P 28	RED x P 24
P 90-2	Selection from EC 242692
Bio L 212	Somaclone developed from P 24
Bio R 202	Somaclone developed from P 24
Bio R 231	Somaclone developed from P 24
Bio L 208	Somaclone developed from P 24
P 94-3	P 505 x P 28
RLS 3	Selection from P 24
RLS 6	Selection from P 24

Disease and pest resistance

Not much emphasis has been given on other aspects (biotic and abiotic stresses) of *Lathyrus*, as low ODAP content is considered to be the primary objective of research. However, thrips are one of the serious pests to this crop, particularly in central zone of India. Certain lines from germplasm like RLK-1, RLK-281, RLK-617 and RPL-26 have been reported by Raipur centre as thrips tolerant. Also, powdery mildew and downy mildew are two major diseases which infect this crop. At Raipur, RPL 26 and RL 41 have been found to be tolerant to powdery mildew. In addition, a number of collections from surrounding Raipur area have shown resistance to downy mildew. Some of these donors are being used in crossing programmes.

Uses

Lathyrus sativus is used in many ways for human consumption and cattle feed. Some of the major uses are:

i) Mainly as *dal* which is a principal source of protein for poor people. It is preferred due to its better taste.
ii) The flour, *besan,* is used for preparing different food items.
iii) Green pods and young tendrils of *Lathyrus* are consumed as green vegetable.
iv) Vegetative parts are widely used as fodder for cattle. After threshing, the dried hay and after milling the bran of *Lathyrus* seed are also used as cattle feed.
v) Flour is used as feed for lactating cattle.
vi) Improves soil fertility by fixing the atmospheric nitrogen.

Conservation

The cultivated area under this crop is declining rapidly and landraces diversity is in danger of being lost. Also, with the development of low ODAP genotypes with good yield potential, the landraces will be rapidly replaced by the improved varieties resulting in the extinction of landraces. Therefore, conservation of available genetic resources for future use is very essential. About 2600 collections are being maintained at Raipur as active collections. At

Table 4. Performance of low ODAP genotypes with respect to grain yield

Geno-types	Zones	Grain yield (kg/ha^{-1}) 1994-95	1995-96	1996-97	Average over Zones & years	ODAP content (%) Year	Average over Zones	Average over Zones & Year
P 24	NWPZ	556(1)	1 367(1)	-	984	1994-95	0.285	0.277
	NEPZ	950(3)	742(1)	731(2)		1995-96	0.274	
	CZ	1 126(4)	951(3)	1 452(6)		1996-97	0.271	
LSD 3	NWPZ	347(1)	1 227(1)	-	1246	1994-95	0.228	0.297
	NEPZ	2 308(1)	947(1)	1 096(2)		1995-96	0.363	
	CZ	1 378(1)	1 211(3)	1 448(4)		1996-97	0.299	
Bio L 212	NWPZ	764(1)	1 031(1)	-	1305	1994-95	0.088	0.093
	NEPZ	1 751(3)	1 350(1)	1 161(2)		1995-96	0.095	
	CZ	1 741(4)	1 182(3)	1 463(6)		1996-97	0.095	
Bio R 202	NWPZ	503(1)	1 141(1)	-	1189	1994-95	0.050	0.077
	NEPZ	1 572(3)	1 076(1)	1 070(2)		1995-96	0.085	
	CZ	1 414(4)	1 107(3)	1 628(6)		1996-97	0.095	
Bio R 231	NWPZ	503(1)	1 141(1)	-	1187	1994-95	0.077	0.114
	NEPZ	1 356(3)	986(1)	1 269(2)		1995-96	0.152	
	CZ	1 566(4)	1 164(3)	1 508(6)		1996-97	0.112	
Bio L 208	NWPZ	486(1)	1 016(1)	-	969	1994-95	0.088	0.111
	NEPZ	1 278(3)	853(1)	-		1995-96	0.071	
	CZ	1 410(4)	767(3)	-		1996-97	0.174	
P 28	NWPZ	521(1)	1 047(1)	-	966	1994-95	0.177	0.191
	NEPZ	1 114(3)	931(1)	-		1995-96	0.204	
	CZ	1 118(3)	1 060(3)	-		1996-97	-	
P 90-2	NWPZ	556(1)	1 375(1)	-	701	1994-95	-	0.297
	NEPZ	-	222(1)	-		1995-96	0.297	
	CZ	-	646(3)	-		1996-97	-	
Sel. 505	NWPZ	-	1 328(1)	-	1122	1994-95	-	0.348
	NEPZ	-	1 135(1)	-		1995-96	0.348	
	CZ	-	903(3)	-		1996-97	-	
P 94-3	NWPZ	487(1)	1 414(1)	-	1175	1994-95	0.123	0.149
	NEPZ	1 403(3)	1 085(1)	973(2)		1995-96	0.169	
	CZ	1 566(3)	1 035(3)	1 437(6)		1996-97	0.156	
RLS 6	NWPZ	-	1 000(1)	-	966	1994-95	-	0.261
	NEPZ	-	792(1)	556(2)		1995-96	0.263	
	CZ	-	1 087(3)	1 393(6)		1996-97	0.259	
RLS3	NWPZ	-	742(1)	-	736	1994-95	-	0.341
	NEPZ	-	238(1)	354(2)		1995-96	0.332	
	CZ	-	1 031(3)	1 314(6)		1996-97	0.350	
LS 157-14	NWPZ	-	969(1)	-	953	1994-95	-	0.187
	NEPZ	-	669(1)	912(2)		1995-96	0.189	
	CZ	-	926(3)	1 291(5)		1996-97	0.184	

Figures in parenthesis represent number of locations
NWPZ = North Western Plain Zone
NEPZ = North Eastern Plain Zone
CZ = Central Zone

NBPGR, more than 1000 accessions are conserved in long-term storage (base collection). However, there is need to have medium term storage facility at the regional stations to facilitate conservation and utilization of diversity of this crop.

More centres may be identified in the major *Lathyrus* growing states of India like Dholi and Ranchi in Bihar, Berhampur in West Bengal, Bilaspur and Rewa in Madhya Pradesh, and Akola in Maharashtra to collect and maintain the available landraces of the respective states with duplicate set conserved at NBPGR.

Lathyrus and lathyrism

Lathyrus sativus has been a subject of controversy among agricultural scientists, nutrition experts and the farming community for many decades. Its cultivation was banned by the Government in 1961 under the Prevention of Food Adulteration Act 1954, on the ground that its consumption was harmful to health.

In order to review afresh whether consumption of *Lathyrus* causes lathyrism, a high powered committee comprising representatives of ICAR, Ministry of Health, Agriculture, Governments of major *Lathyrus* growing states and National Institute of Nutrition has been set up. On the recommendation of the Committee, *Lathyrus* feeding experiments are going on at Central Drug Research Institute (CDRI), Lucknow on monkeys. Also, similar type of study on rats is being done by Industrial Toxicology Research Centre (ITRC), Lucknow.

The objective of the study at the Central Drug Research Institute (CDRI), Lucknow is to evalvate long-term (12 months) systemic toxicity in rhesus monkey for:

i) Cooked *khesari dal* paste/slurry with high ODAP content

ii) Cooked *khesari dal* paste/slury with low ODAP content

A total of 64 rhesus monkeys are being used for this study. Cooked paste of high and low ODAP *khesari dal* are administered by dietary route to groups of 8 animals (4 males + 4 females) each at the following dose level for 12 months:

Low Dose	-	2.50 g of *dal*/kg body weight
Intermediate Dose	-	6.25 g of *dal*/kg body weight
High Dose	-	12.50 g of *dal*/kg body weight

Control animals are fed with comparable volumes of distilled water.

The parameters of study includes daily obserervations on general behaviour and activity of the animals, periodical recording of food and water intake, body weight, morbidity and mortality, periodical analysis of blood and urine and at termination, macroscopic and histopathological study of different body organs. The feeding study will be completed by September 1998 and the final results are expected by the end of 1998.

Lathyrus network

Network is an effective tool to enable collaborating countries to carry out their responsibility to conserve, use and share genetic resources and other informations (Riley 1996). Countries holding collections of *Lathyrus* diversity need to examine methods by which this can be done most effectively and inexpensively. A collection of available diversity will be useful to the breeders as parents in hybridization for developing improved varieties of *Lathyrus*.

Mechanism and operation

- Objectives : *Lathyrus* germplasm collecting, exchange, evaluation, characterization, conservation and utilization.
- Member Countries : Asian countries and International Institutions like ICARDA, IPGRI.
- Species/Genepool : Primarily *Lathyrus sativus. L. cicera* and *L. ochrus* may also be considered

- Networking : Country coordinator and a Steering Committee
- Activities :
  - Status of existing *Lathyrus* germplasm with different member countries.
  - To establish a safety duplicate collection.
  - Database containing passport data and descriptor data
  - To develop and publish a Germplasm Directory of the addresses and *ex situ* collections held in different gene banks.
  - Multilocation testing across the region.
  - Collaborative breeding programmes for developing low ODAP and high yielding genotypes with resistance to biotic and abiotic stresses.
  - Basic studies e.g., genetics of various traits, micro-biological and physiological studies, wide hybridization, preparation of linkage maps, studies on molecular markers and genetic engineering approaches.
- Funding :
  - Member countries and International Organizations.
  - Other Countries and donors like Asian Development Bank, IDRC, UNDP and the World Bank.

Future emphasis

1. Collecting of landraces from unexplored areas.
2. Development of stable genotypes containing very low or no ODAP content.
3. Development of genotypes with high seed yield, herbage production and harvest index.
4. Development of genotypes with resistance to various biotic and abiotic stresses.
5. Development of genotypes with other traits like earliness, deep rooted, small seeded, erect plant habit and medium plant height for *Utera* system and also for replacement of follows with *Lathyrus sativus*.
6. Development of genotypes with medium maturity, higher biomass, bold seed and responsive to fertilizers and irrigations for irrigated areas with yield potential of 3 t ha^{-1}.
7. Development of short duration *Lathyrus ochrus* genotypes for replacement of fallows to increase forage production and improve soil fertility.
8. The techniques of molecular genetics may be applied to characterize the genes and identify important linkages to facilitate gene transfer to suitable agronomic basis.
9. Development of *Lathyrus* Network.

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Networking for collaborative research and technology exchange in *Lathyrus*

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Introduction

Networks are increasingly becoming important in agricultural research as a means of effectively and efficiently using limited staff, facilities and funds to achieve research goals. Networking approach is being used to avoid duplication of effort and to engage a critical mass of scientists, at relatively low cost, to address and solve specific problems confronting the network members. Networks also encourage and enhance interaction and exchange of information, knowledge and technology among members.

Lathyrus network

Riley (1996) discussed the network approach for *Lathyrus sativus.* He reviewed the past research collaboration under INILSEL (International Network for the Improvement of *Lathyrus sativus* and Eradication of Lathyrism) and suggested that a regional network for *Lathyrus* may be necessary in Asia.

Regional networks are formed by memebrs (scientists and research administrators) from countries in a region, based on the expressed need of the members to form such an association for collaborative research and technology exchange. Such networks use the existing facilities and staff, and exploit the comparative advantages of member countries to carry out joint research. The stronger NARS in the network assist the weaker NARS to become self reliant.

Specific objectives of Lathyrus network

- Strengthen linkages and enhance conservation and exchange of germplasm, breeding material, information and technology options among members,
- Facilitate collaborative research among members to address and solve high priority production and utilization constraints, and
- Assist in improving the research and extension capability of member countries through human resource development.

Network structure

Membership

Membership is the core or body of the network. National programmes that have substantial area and production of *Lathyrus,* and interested in working together to alleviate production and consumption constraints, can become members of the network. Other scientists from interested regional and international research insitutions working in Asia, can become members depending on their need and interest.

The proposed network structure is given in Fig. 1. To be effective, the network needs a Memorandum of Agreement among member countries to facilitate collaborative research and for administrative procedures that are essential for joint research, movement of staff, material and equipment, among network member countries.

A Coordination Unit (CU) is essential to facilitate coordination of logistic support to network activities. Depending on the work load of the network, it is mandatory to appoint a full-time or part-time Network Coordinator to provide the necessary administrative and logistic support, and facilitate network activities.

Each member country may nominate a senior scientist as the Country Coordinator for in-country coordination of network activities.

A Steering Committee of the Country Coordinators may be needed to oversee the network activities and provide guidance on future collaborative research.

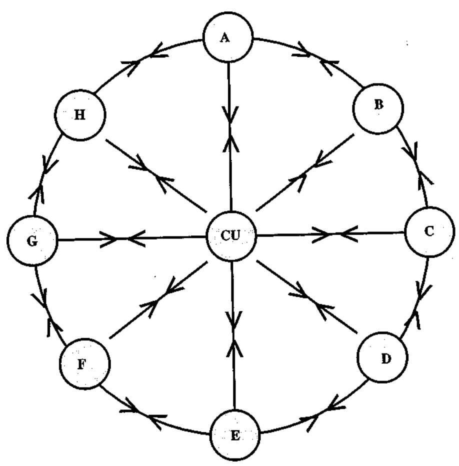
Network activities

Based on the need, interest, and comparative advantage of member countries, the network may have the following activities:

- *Collaborative research workplans*: A focussed and time-bound workplan would help in timely execution of planned research to address the needs of the network research agenda.
- *Exchange of germplasm and breeding material*: Genetic resources and improved breeding material are shared with the scientists in the network member countries. Network may facilitate the exchange and assists NARS in testing, evaluation and use of these genetic materials.
- *Training*: Enhancing of skills and learning of new techniques will improve the research capability of member countries.
- I*nformation exchange*: Exchange of research results, technology and information among network members is essential for dissemination of information.
- *Regional workshops and meetings*: Scientists working on collaborative research agenda need to meet once in 2-3 years to interact, exchange information and plan for future research at regional workshops and meetings.

Conclusion

Members can deliberate and decide whether they need a separate formal network for *Lathyrus* or activities can be operated as a 'Working Group', with one of the scientists taking lead and be responsible for coordination. Although in-country network-related collaborative activities are funded by members, coordination and related activities (training, meetings, etc.) need external funding. Whether this funding is available, or it will become available in the future needs to be clarified. It is suggested that the *Lathyrus* group may be linked or supported by other institutions/regional fora such as Asia Pacific Association for Agricultural Research Insitutions (APAARI) or other regional networks.



CU = Coordination Unit
A to H = Network member countries
>< = Interaction and exchange

Fig. 1. Proposed structure for a *Lathyrus* network

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Performance of low ODAP somaclones of *Lathyrus sativus*

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Introduction

By exploiting somaclonal variation, a large number of *Lathyrus sativus* variants have been developed with respect to morphological characteristices as well as biochemical aspects which were discussed in our earlier report (Mehta and Santha 1996). In this paper, the performance of the low ODAP somaclones at Indian Agricultural Research Institute (IARI) farm as well as that of the few selected ones in all India Coordinate Varietal Trails conducted by Indian Institute of Pulses Research (IIPR), Kanpur are discussed.

Materials

Eighteen low ODAP (<0.1%) somaclones with better yield potential as compared to parent P 24, were grown at IARI Farm alongwith parent P 24. The seed yield and ODAP content of the seeds were estimated at the time of maturity.

Four of the somaclones viz., Bio L208, Bio L212, Bio R202 and Bio R231 alongwith parent P 24 were selected for All India coordinated Varietal Trial programmes conducted by Indian Institute of Pulses Reseach (IIPR), alongwith other checks. These were grown at different geographical zones and their performance evaluated with respect to yield and ODAP content.

Result and discussion

The low ODAP somaclones alongwith parent P 24 were grown at IARI farm for the last four consecutive years and their ODAP content estimated at maturity. The plants were grown under natural conditions without any irrigation or nitrogenous fertilizer application during their growth. The plants were covered with nets to prevent out-crossing through honey bees. The seed yield was noted at the time of harvest. The ODAP content in the somaclones for the 4 consecutive seasons and their average yield are presented in Table 1. The data showed stability with respect to the low ODAP nature of the somaclones. The ODAP content varied from 0.031 to 0.128% in somaclones as against 0.3 to 0.592% in parent P 24.

The average yield of somaclones varied form 33.65 kg ha^{-1} in case of Bio L208 to 18.75 kg ha^{-1} in Bio 164, as against an average yield of 13.0 kg ha^{-1} in parent.

Five of the somaclones were grown in CVT at Raipur during *Rabi* (Post-rainy) 1993 alongwith P 24 and other entries. The ODAP content of these somaclones alongwith other entries are shown in Table 2. From the values presented in the Table, it can be seen that the somaclones developed in our laboratory had lower ODAP content (<0.1 %) as compared to check P 24 and other entries. Bio L203 showed the lowest ODAP content of 0.037%.

Four somaclones Bio L208, Bio L212, Bio R202, Bio R231 and P 24 were grown at different locationes in *Rabi* 1994-95 under AVTI. The ODAP content of the seeds grown at different locations are shown in Table 3. At all locations they showed lower ODAP than parent.

The average yield of somaclones (kg ha^{-1}) at different geographical zones NEPZ and CZ under AVT-1 1994-95 are shown in Table 4 A and B. In both the zones they performed better than parent P 24, Bio L212 ranked first in both zones. At Bharari Bio L212 yielded as high as 3q ha^{-1}.

Three of these somaclones (Bio L208, Bio L212 and Bio R202) were grown at 6 different locations in Rajasthan and the ODAP content estimated. The low ODAP nature remained almost unchanged in these somaclones at various locations (Table 5).

Table 1. ODAP and yield in different somaclones of *Lathyrus sativus*

Somaclones	ODAP (%)				Yield
	(1994)	(1995)	(1996)	(1997)	($q\ ha^{-1}$)
BIO 158	0.044	0.056	0.070	0.038	19.42
BIO 164	0.034	0.031	0.089	0.053	18.75
BIO L203	0.063	0.065	0.081	0.034	22.12
BIO L207	0.050	0.044	0.095	0.069	19.46
BIO L208	0.028	0.047	0.125	0.056	33.65
BIO L212	0.037	0.038	0.087	0.050	23.40
BIO L254	0.046	0.062	0.095	0.050	20.87
BIO L256	0.065	0.050	0.065	0.047	20.00
BIO L257	0.063	0.059	0.105	0.065	23.00
BIO R202	0.034	0.056	0.117	0.072	27.12
BIO R215	0.041	0.100	0.150	0.150	25.65
BIO R224	0.046	0.056	0.097	0.047	20.75
BIO R229	0.063	0.068	0.111	0.063	23.61
BIO R231	0.050	0.046	0.128	0.072	27.51
BIO R233	0.069	0.075	0.132	0.132	28.12
BIO 1218	0.059	0.056	0.103	0.041	20.00
BIO 1222	0.031	0.040	0.076	0.076	31.65
BIO 1230	0.044	0.050	0.130	0.076	22.71
P 24 (Check)	0.321	0.320	0.592	0.365	13.00

Table 2. ODAP content of *Lathyrus sativus* varieties grown in CVT at Raipur during 1992-93

Varieties	ODAP content (%)
Pusa 24	0.220
LSD 3	0.207
REW A2-28	0.248
RL 298-104	0.345
P 28	0.108
P 90	0.287
P 90 2	0.159
RLS 3	0.212
RLS 4	0.213
RLS 5	0.208
Bio R 231	0.089
Bio I 222	0.045
Bio L 203	0.037
Bio R 227	0.145
Bio R 202	0.048

During *Rabi* 1995-96 these somaclones were grown under special CVT programme at various locations and seeds were analyzed both at Biochemistry Division, IARI (Table 6) as well as IGAU, Raipur (Table 7). From Table 7 it can be seen that Bio L208 had the lowest average ODAP content. The yield data for different zones under the special CVT- (1995-96) are shown in Table 8. Bio L212 ranked first in NEPZ and second in CZ in yield.

Based on the performance of the somaclones under various All India Varietal trials and recommendations by Central Sub-committee in crop standards, notification and release of

Table 3. ODAP content of different somaclones of *Lathyrus sativus* grown at different locations in *Rabi* 1994-95 (under All India Varietal Trail-1)

Varieties	Akola	Amgoan	Berhampur	Dholi	Delhi	Kanpur	Raipur
Bio L203	0.088	-	0.103	**	0.065	0.078	0.108
Bio L208	0.143	**	0.141	**	0.047	0.096	0.168
Bio L212	**	0.116	0.094	0.112	0.038	0.086	0.119
Bio R202	0.106	0.116	0.109	0.125	0.056	0.074	0.103
Bio R231	0.156	0.175	0.113	0.112	0.046	0.085	0.123
LSD-3	-	-	0.505	-	-	0.338	0.383
P 24	0.344	0.378	0.468	0.393	0.320	0.356	0.489
P 28	0.312	0.550	0.369	0.386	0.157	0.161	0.322
P 94-1	0.412	-	0.528	0.138	0.308	0.417	-
P 94-2	-	0.572	-	-	0.305	0.276	-
P 94-3	0.215	0.194	-	-	0.111	0.131	-
RLS-6	0.250	0.365	0.447	-	-	-	-

Table 4(a). Yield (kg ha^{-1}) of *Lathyrus sativus* varieties under AVT-1 in *Rabi* (1994-95) from North-Eastern Plain Zone

Variety	Berhampur	Dholi	Kanpur	Zone mean
P 24 check	764	836	1 250	950
P 28	819	853	1 670	1 114
P 94-1	1 031	867	1 765	1 221
P 94-2	889	129	1 705	908
P 94-3	878	711	2 621	1 403
Bio R231	771	969	2 328	1 356
Bio L208	924	626	2 283	1 278
Bio R202	990	1 053	2 673	1 572
Bio L212	1 420	1 228	2 605	1 751
Bio L203	983	687	1 888	1 186

Table 4(b). Yield (kg ha^{-1}) of *Lathyrus sativus* varieties under AVT-1 in *Rabi* (1994-95) from Central Zone

Varieties	Bharari	Amagaon	Raipur	Akola	Zone mean	Raipur (*Utera*)
P 24 (Check)	1 758	1 233	952	562	1 126	1 428
P 28	1 178	-	1 580	833	940	1 118
P 94-1	2 881	-	-	643	1 487	-
P 94-2	2 754	851	-	-	1 803	-
Bio L208	2 268	1 528	1 111	731	1 410	-
Bio R202	2 198	1 424	1 450	782	1 414	1 178
Bio L212	3 541	1 380	1 230	811	1 741	-
Bio L203	2 093	-	1 111	1 145	1 445	1 232
Bio R231	2 738	1 528	952	1 057	1 566	1 178

varieties for agriculural crops recommended the release of Bio L212 and Ministry of Agriculture, Government of India notified the release of Ratan-Bio L212. This has been recommended for growing in the Central and North Eastern Plain Zone. This is the first ever variety of *Lathyrus sativus* released for cultivation in recent years based on low ODAP

Table 5. ODAP content of different somaclones of *Lathyrus sativus* grown at different locations in Rajasthan in *Rabi* 1994-95

Somaclones	Ajmer	Bharatpur	Bundi	Chittorgarh	Srikaranpur	Sumerpur
Bio L208 (Moti)	0.053	0.100	0.078	0.096	0.072	0.094
Bio L212 (Ratan)	0.072	0.081	0.181	0.128	0.069	0.063
Bio R202	0.084	0.069	0.062	0.137	0.053	0.059

Table 6. ODAP content (%) of *Lathyrus sativus* varieties grown in special CVT during 1995-96 (Estimation was done at IARI, New Delhi)

Varieties	Raipur	Bilaspur Sarkanda	Berhampur	Delhi	Kanpur	Sakoli	Dholi	Rewa
Bio R231	0.245	0.139	0.133	0.092	0.091	0.280	0.120	0.153
Pusa 24	0.700	0.316	0.437	0.227	0.379	0.580	-	0.400
Pusa 28	0.352	0.214	0.333	0.162	0.226	0.780	0.230	0.266
LSD-3	0.667	0.424	0.550	0.315	0.530	0.630	0.430	0.440
P 90-2	0.688	0.217	0.732	0.256	0.360	0.520	0.280	0.330
Sel 505	0.745	0.270	0.575	-	0.453	0.560	0.300	-
P 94-3	0.332	0.127	-	0.118	0.248	0.303	0.160	0.370
RLS3	0.710	0.411	0.535	0.321	0.400	0.670	0.430	0.456
Bio L208	0.224	0.070	0.147	0.090	0.060	0.206	0.091	0.128
Bio L212	0.230	0.069	0.139	0.063	0.100	0.200	0.090	0.116
Bio R202	0.263	0.067	0.127	0.057	0.092	0.250	0.096	0.106
LS 157-14	0.425	0.214	0.293	0.169	0.280	0.540	0.130	0.256
RLS6	0.520	0.291	0.432	0.274	0.147	0.480	0.260	0.330
Local	0.630	0.331	0.575	-	-	0.700	0.460	0.490

Table 7. ODAP content (%) in somaclones of *Lathyrus sativus* varieties grown under special CVT during 1995-96 (Estimation was done at IGAU, Raipur)

Somaclone	Raipur	Akola	Bilaspur	Berhamur	Delhi	Kanpur	Amagoan	Sokali	Average
Bio L208	0.131	0.096	0.046	0.102	0.052	0.055	0.161	-	0.071 (I)
Bio L212	0.154	0.135	0.042	0.092	0.046	0.056	0.108	0.125	0.095 (III)
Bio R202	0.151	0.089	0.069	0.084	0.039	0.054	0.083	0.113	0.085 (II)
Bio R231	0.343	0.185	0.061	0.099	0.073	0.093	0.185	0.186	0.152
P 24 (check)	0.436	0.267	0.168	0.286	0.153	0.217	0.415	0.252	0.274

Values given in parentheses indicate rank.

and yield performance. Release of this extremely low ODAP variety should help in lifting the ban imposed on *Lathyrus*. Some steps have been taken in this regard and a high power committee constituted by Government of India and Indian Council of Medicinal Research (ICMR) to look into this matter, recommended the conducting of nutritional feeding experiments on monkeys to know the toxicoligical effects. This work has been assigned to Central Toxicological Research Institute, Lucknow and we have provided 65 q of Bio L212 (Ratan) dal as well as Check P 24 to them.

Table 8. Yield of *Lathyrus sativus* somaclones under special CVT (1995-96)

Somaclones	Yield (kg ha^{-1})		
	NEPZ	CZ	NWPZ
Bio L208	853	767	1 016
Bio L212	1 350 (I)	1 182 (II)	1 031
Bio R202	1 076	1 107	1 141
Bio R231	986	1 164 (III)	1 141
P24 (check)	742	951	1 367

Values given in parentheses indicate rank.

But a lot of extension work will be needed to popularise this. Being a bee pollinated crop extra care will be needed to maintain genetic purity for neurotoxin level. It is also necessary to discourage growing of other high toxin varieties side by side as well as an admixture.

Acknowledgments

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References

Mehta, S.L. and I.M. Santha. 1996. Plant biotechnology for development of non-toxic strains on *Lathyrus sativus*. Pp. 129-138 *in Lathyrus* Genetic Resources in Asia: Proceedings of a Regional Workshop, 27-29 December 1995, Indira Gandhi Agricultural University, Raipur, India (R.K. Arora, P.N. Mathur, K.W. Riley and Y. Adham, eds.). IPGRI Office for South Asia, New Delhi.

Technical Programme

IPGRI-ICARDA-ICAR Regional Working Group Meeting on *Lathyrus* Genetic Resources Network

8-10 December 1997

[Venue: National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, India]

Sunday, 7 December 1997

Arrival of participants : Hotel Janpath

Monday, 8 December 1997

0900-1000 Distribution of workshop materials,
Administrative arrangements.

1000-1100 **Opening Session**

Welcome and Introduction	:	R.K. Arora	IPGRI
Remarks	:	J.L. Karihaloo	NBPGR
		L. Robertson	ICARDA
		V. Ramanatha Rao	IPGRI
Chairman's address	:	Mangala Rai	DDG(CS), ICAR
Vote of thanks	:	P.N. Mathur	IPGRI

[1100-1130: Tea/coffee break]

1130-1300 **Session I: Discussion on workshop agenda and presentation of status reports**

Chairman : Dr. Mangala Rai
Co-Chairman : Dr. J.L. Karihaloo

1130-1200 Discussion on workshop agenda
1200-1700 Presentation of status reports - progress since last workshop

1200-1230	India	R.L. Pandey
1230-1300	Bangladesh	M.A. Malek

[1300-1400: Lunch break]

1400-1700 **Session I: To continue**

1400-1430	Nepal	M. Joshi
1430-1500	ICARDA	Larry Robertson

[1500-1515: Tea/Coffee break]

1515-1545	CLIMA	K.H.M. Siddique
1545-1615	IPGRI	V. Ramanatha Rao
1615-1700	Discussion	

Tuesday, 9 December 1997

0900-1030 Visit to NBPGR Genebank

[1030-1100: Tea/Coffee break]

1100-1300 **Session II: Need for *Lathyrus* Network**

Chairman : Dr. Larry Robertson
Co-Chairman : Dr. Fernand Lambein

Improvement and Utilization	S.L. Mehta A.S. Asthana
Regional *Lathyrus* Database	P.N. Mathur
Discussion on *Lathyrus* Network	

[1300-1400: Lunch Break]

1400-1700 **Session II: To continue (Finalization of *Lathyrus* Network Document)**

Chairman : Dr. Larry Robertson
Co-Chairman : Dr. K.H.M. Siddiqe
Dr. A.N. Asthana

Discussion on Network Proposal

Wednesday, 10 October 1997

0900-1030 **Session II: To continue**

Discussion on Network Proposal

[1030-1100: Tea/Coffee Break]

1100-1300 **Session III: Concluding Session**

Chairman : Dr. N.B. Singh

Presentation of working group discussion/Remarks : Larry Robertson
V. Ramanatha Rao
R.K. Arora

Vote of thanks : J.L. Karihaloo

[1300-1400: Lunch Break]

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Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
ADF	Acid Detergent Fibre
APAARI	Asia Pacific Association for Agricultural Research Institutes
BADC	Bangladesh Agricultural Development Cooperation
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BINA	Bangladesh Institute of Nuclear Agriculture
CBD	Convention on Biological Diversity
CDRI	Central Drug Research Institute, India
CFC	Common Fund for Commodities
CGIAR	Consultative Group on International Agricultural Research
CICR	Central Institute for Cotton Research, India
CLIMA	Centre for Legumes in Mediterranean Agriculture, Australia
CWANA	Central and West Asia and North Africa
DAE	Directorate of Agriculture Extension, Bangladesh
DIP	Data Interchange Protocol
ECPGR	European Cooperative Programme on Plant Genetic Resources
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
GIS	Geographical Information System
GRC	Genetic Resources Centre, Bangladesh
GRDC	Grains Research and development Cooperation, Australia
IARCs	International Agricultural Research Centres
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICARDA	International Centre for Agricultural Research in Dry Areas
ICMR	Indian Council of Medical Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre, Canada
IFAD	International Fund for Agricultural Development
IGAU	Indira Gandhi Agricultural University, India
IIPR	Indian Institute of Pulses Research
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INIBAP	International Network for the Improvement of Banana and Plantain
INILSEL	International Network for the Improvement of *Lathyrus sativus* and Eradication of Lathyrism

INTAS	International Association for the Promotion of Cooperation with Scientists from the New Independent States of the former Soviet Union
IPGRI	International Plant Genetic Resources Institute
ITRC	Industrial Toxicology Research Centre, India
LGRN	Lathyrus Genetic Resources Network
MTA	Material Transfer Agreement
NAA	Nepal Agricultural Association
NARC	Nepal Agricultural Research Council
NARS	National Agricultural Research Systems
NBPGR	National Bureau of Plant Genetic Resources, India
NDF	Neutral Detergent Fibre
NGLRP	National Grain Legume Research Programme, Nepal
NGO	Non-Governmental Organization
NIN	National Institute of Nutrition, India
NPs	National Programmes
NUC	Neglected and Underutilized Species
ODAP	ß-N-Oxalyl-L-α,ß-Diaminopropionic acid
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
PRC	Pulses Research Centre, Bangladesh
RIRDC	Rural Industries Research and Development Cooperation, Australia
UMS	Underutilized Species of the Mediterranean
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WANA	West Asia and North Africa
WANANET	West Asia and North Africa Plant Genetic Resources Network