GRAIN LEGUMES

AEP

The magazine of the European Association for Grain Legume Research
Le magazine de l'Association Européenne de recherche sur les Protéagineux

ISSUE No. 47 3rd quarter 2006

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Rendez-vous à Lisbon-2007

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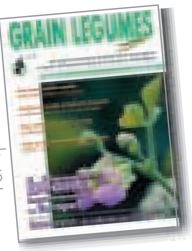

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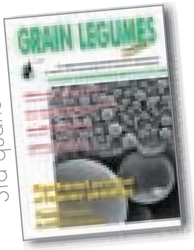

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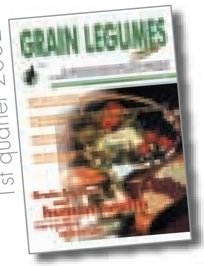

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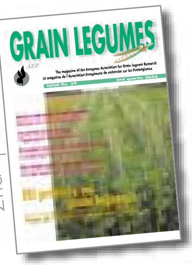

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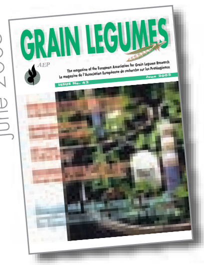

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2nd quarter 2006


EDITORIAL

Meeting the needs of stakeholders is currently a significant concern in R&D activities. It is logical that research effort must be matched with need, but also that the beneficiaries of R&D need to sustain the R&D effort.

It is good idea that the policy-makers want to enhance the way in which research results are transferred and transformed into technologies and applications that are assets for economic competition. They should also keep in mind that, historically, scientific breakthrough often came about when targeting a different objective, and that the future may offer unexpected developments that need to be anticipated by considering different scenarios.

The challenge is therefore to find a method whereby those with economic concerns articulate effectively with those concerned with the research process, taking into account the different levels of analysis from short- or medium-term to long-term objectives.

Such interfacing should allow freedom for the two communities respectively, as well as mutual benefits from the exchanges. These exchanges are not only the exchange of funds for results (and vice versa) but also the benefits from different expertise and viewpoints that promote their individual businesses, and the solutions found as a result of a joint assessment of a given problem.

This kind of cooperation might be ambitious and time-consuming but it must surely be the most beneficial way forward. Let's see how to apply this concept – at the international level, within FP7 procedures, among members of the legume community, within AEP and GL-TTP, or between two identified partners.

Anne SCHNEIDER
Managing Editor

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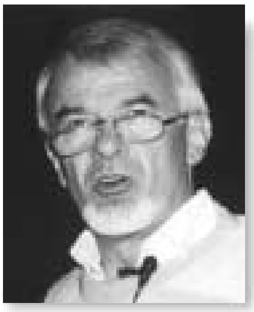
Carte blanche to...



Jean Dénarié*

A magazine for all legumes of interest

Greenhouse gases accumulating in the atmosphere resulting in global warming, are a major threat to the environment. Increased energy demands in a developing world and decreasing fossil fuel reserves are resulting in persisting increases of oil price. These constraints are encouraging an urgent search for renewable sources of energy. Important projects are designed to progressively (and partially) replace fossil fuels by biomass to produce energy and raw materials for industry. Biorefineries for the large-scale production of biofuels and biomaterials are being planned in agricultural regions extending the mission of agriculture to provide not only food but also energy and bioproducts.

It is clear, however, that nitrogen (N) will rapidly become a major limiting factor for large-scale biomass production. N fertilisers can be justified for food and feed production because of the added value of these crops; for the production of bioenergy fertilisers would not make sense since their synthesis and application burn large amounts of fossil fuels and are an important source of greenhouse gases.

*Legumes, as N-fixing crops, will increase in importance in the coming decades. Grain legumes will remain central for food and feed, but for biomass production high biomass and low input perennial herbaceous legumes such as lucerne, or legume trees such as black locust (*Robinia pseudoacacia*) are likely to become important. Forests are important in carbon dioxide fixation, but their biomass production is frequently limited by N. In temperate regions N-fixing trees represent less than 1% of forest areas. The potential and challenge to increase the use of N-fixing plants in Europe are really enormous.*

During the last decade AEP has played a very important role, in a difficult context, promoting interdisciplinary research on grain legumes in Europe. It would make sense that the competent networks in place, the genetic and genomic resources generated for model and crop legumes, the systemic approaches based on agronomy, environmental sciences and economics, should be used in the future not only for grain legumes but for all useful legumes. Exploiting the genetic diversity within legume species will be necessary to develop sustainable agricultural systems satisfying the energetic and environment challenges. My belief is that in the near future AEP and its Grain Legumes *magazine should extend their interest and action beyond grain legumes to promote interdisciplinary research to all legumes of interest, including herbaceous perennials and trees.*

Long live AEP! ■

*LIPM CNRS-INRA, Castanet-Tolosan, France
denarie@toulouse.inra.fr

Expression of Interest

Dissemination Conference of GLIP and other legume-related activities

6th European Conference on grain legumes

– Integrative approach for sustainable agriculture –

Monday 12 to Thursday 15 November 2007
Lisbon Congress Centre, Portugal

The EU GRAIN LEGUMES Integrated Project (GLIP, February 2004 to February 2008) is a large consortium aiming to integrate research relevant to grain legume species, combining activities in disciplines from genomics to economics. This project wishes to combine with other national or international programmes on legumes to provide a timely assessment of the progress in and prospects for legume research.

This conference will bring together those interested in legumes and especially legumes in agriculture. This will provide conference participants with the opportunity to assess the outputs of several coordinated research activities and to discuss prospects for their use and to prepare future collaborations.

Programme

Session 1. Highlights from the results of the EU project GLIP
Session 2. Economics and global trade
Session 3. Seed formation and composition and feed/food uses
Session 4. Food and human health
Session 5. Feed, processing and animal nutrition
Session 6. Legume diversity, evolution, and comparative genomics
Session 7. Plant development, growth and functioning
Session 8. Biotic and abiotic stress
Session 9. Agro-ecology and environment (diversity of species & crop systems)
Session 10. Crop management, agronomy and Integrated Disease Management
Session 11. Symbiosis

On the basis of the expressions of interest about listed topics (see web pages), 16 Thematic Workshops will be designed for round-table discussions in smaller groups on a major topic defined by the moderator.

The posters will be displayed throughout the Conference and two specific poster sessions will be organised.

Some satellite meeting could be organised at ITQB on Friday 16 November.

Please indicate your intention to participate in 'LISBON-2007' to Lisbon2007@gmail.com by **11 December 2006**, together with a summary if you wish to submit a contribution.
Web: www.grainlegumes.com

GLIP extended to non-EU countries

The EU GRAIN LEGUMES Integrated Project (GLIP) has enlarged its membership following a successful submission to the EU call related to 'Targeted Third Countries'.

Grain legumes (peas, faba beans, common beans, groundnut, etc) are important throughout the world; outside the EU they generally comprise an important component of agricultural systems and are often a significant component of human diets. Collaboration between the original and the new partners in GLIP will provide mutual benefits, extending the range of species and environmental conditions studied, and so widening the potential reach of information from model systems.

The 10 new TTC contractors in GLIP are from Russia, Egypt, the West Bank and Gaza Strip, Tunisia, Morocco, Brazil, China and South Africa. They will complement the activities of GLIP especially in the areas of (i) biotic and abiotic stress, especially important in the Mediterranean regions, and also (ii) comparative genetics, with expertise in legume species less developed in the previous consortium.

The specific objectives of GLIP with the extended partnership are fourfold:

– to use the diversity of *Medicago truncatula* in the Mediterranean Basin to better understand drought stress response;
– to understand the impact of grain legumes diseases in the Mediterranean Basin;
– to extend the number of species studied in the comparative genomics of grain legumes;
– to facilitate the isolation and characterisation of pea genes that impact on crop architecture or performance. ■

Source: T. H. N. Ellis and A. Schneider. (www.eugrainlegumes.org)

A collaborative Ascochyta Network is launched

The production of grain legumes is limited by abiotic and biotic stresses. An important biotic stress is caused by aerial fungi of the *Ascochyta* genus (*A. pinodes* on pea, *A. fabae* on faba bean, *A. rabiei* on chickpea, *A. lentis* on lentil), and this leads to severe damage and yield losses in the major producing regions. To hasten the search for better control mechanisms for these ascochyta blights, expert scientists working on these diseases came together to develop a joint comparative approach for similar pathosystems, different *Ascochyta* species, and different aspects of the pathogen, the plant or the crop production system.

The event was the 'First International Workshop on Ascochyta of Grain Legumes – identifying priorities for collaborative research', held in Le Tronchet (France) on 2–6 July 2006 and it attracted 65 participants from all over the world (13 countries, especially France, Australia, USA, Canada and Spain)[1].

The workshop was for a limited number of participants and the facilities combined accommodation and meeting areas. This format together with the active involvement of all participants made the workshop a success, both in terms of the high standard of scientific presentations and the friendly and fruitful exchanges. Sadly, the event was marked dramatically by the sudden death of one colleague, Bob Henson from the USA.

Four thematic sessions dealt with pathogen biology, plant resistance, epidemiology and integrated disease control, and all were reflected in the poster sessions. Two other sessions were devoted to (i) 'thinking differently' in order to consider inputs from non-legume or non-ascochyta experts and how the scientific results might be better exploited, and (ii) identifying priorities for joint collaboration among the legume ascochyta experts and assessing previous or current international networks.

The major presentations of this first grain legume ascochyta workshop will be published in a special issue of the *European Journal of Plant Pathology.* The positive discussions demonstrated the interest of the participants in maintaining this network and developing active collaborative activities.

Key highlights from the sessions

Pathogen biology

Paul Taylor (Melbourne University, Australia) presented the diagnosis methods, the origin of pathogen diversity and the method to assess this diversity, and also the contribution of genetic diversity to the pathogenicity potential. The notion of virulence was discussed and the definition of races and pathotypes was questioned.

Tobin Peever (Pullman University, USA) dealt with the notion of species among the ascochyta that infect legumes, in terms of biology (the crossing ability of isolates) and phylogeny (classifying groups according to their genetic proximity based on sequence polymorphism) leading to the highlighting of strong host specificity, even if its genetic determinants are not well known. The barriers of the crossing would be either pre or post zygotic. He questioned whether the sexual phase of *Ascochyta pinodes* should belong to the genus *Mycosphaerella*, or should possibly be linked to the genus *Didymella*.

For future work, the network defined three priority areas: 1) better understanding of the pathogen biology: mechanisms of infection (histopathology), the latent role of *Ascochyta* spp., and the role of the three pathogens of the pea ascochyta blight complex, 2) pathotyping with the standardised scoring and evaluation methods, using parametric (epidemiology studies and the effect on inoculum potential) and non-parametric approaches (plant breeding and the effect on yield) 3) genome sequencing.

Plant resistance

Fred Muehlbauer (USDA, USA) explained the different possible genetic controls of the resistance to ascochyta blight in different legumes (major or minor genes, dominants or recessive genes). He highlighted the impact of methodological approaches, the inoculation techniques and the resistance assessment methods on the typology of the genetic control. He also showed the possible pleiotropic effect on the plant development stages, on epidemiological development, and therefore on the resistance evaluation especially at the field level.

The network defined the following priorities for resistance: 1) links between the different results through a harmonisation of techniques for screening material, inoculation and symptoms measurements (parametric methods, exchanges of isolates, accessions and differential hosts, identifying and exchanging markers) 2) link molecular and biological data, 3) implement molecular markers in breeding and exploit tilling populations, 4) better integration of resistance into disease control management studies.

Epidemiology

Bernard Tivoli (INRA, France) showed the similarities and differences in the epidemiological development of ascochyta blights in different legume species, in terms of inoculum types, symptoms, impact on yield, pathogen survival, disease development and modelling of the disease. Discussions related to his proposals for research themes to be developed in the future were lively.

The main priorities defined for the network are: 1) histological studies of the infection process, 2) sources of inoculum (role of soil, ascospores vs. pycniospores), 3) effect of the cultural factors on epidemiological development, 4) testing and application of models in different regions and pathosystems, 5) addition of sub-modules related to ascochyta blights to existing modelling tools.

Integrated disease management

Jenny Davidson (SARDI, Australia) identified the different control methods used for fighting legume ascochyta blights: seed quality, crop rotations, agronomic management, fungicide application and plant genetic resistance. The combination of controls is of high importance and she gave the example of the fungi protection products and plant genetic resistance.


(Photo INRA/Agrocampus Rennes BiO3P)

Delegates at Ascochyta-2007.

The major priorities identified are: 1) integration of knowledge on pathogen and plant phenology into agronomically sound control methods 2) more precise risk assessment, 3) develop decision-making tools and disseminate clear pragmatic messages adapted to regions.

Future collaboration

The first part of the session 'Future collaborations' aimed to assess the major items needing attention in the future in each area (see priorities summarised above) on the basis of the respective state of the art, and elect key priority tasks to be shared at the network level.

The second part of the session was the opportunity to exchange experience on formal or informal collaborative networks at regional or international levels: their potential and difficulties, and the possible opportunities they could provide to meet the concerns of legume ascochyta experts. It was agreed to focus on possible joint tasks or collaborations to be carried out either with existing means or with possible future financial support. Indeed the participants believe that through the respective individual programmes, some exchanges could enable the progress of each group to be optimised and the costs of activities of joint interest shared (for example, collection and screening).

A list of 15 joint priorities was defined for the interdisciplinary network. A questionnaire designed at Le Tronchet has been circulated to all participants and colleagues to assess in more detail the individual and joint interests among the group for each of these priorities.

The network participants will discuss further their collaborations and joint priorities at the Lisbon Conference in November 2007, and a second workshop 'Ascochyta–2009' will be organised in Pullman (USA) in Spring 2009. ■

[1]The workshop was organised by a Local Organising Committee from the joint research unit of INRA/Agrocampus BiO3P (the Biology of Organisms and Populations in relation to Plant Protection) and APBV (Plant Improvement and Biotechnologies), in collaboration with USDA – Agricultural Research Service (Pullman, USA), AEP (European Association for Grain Legume Research) and the French Society of Phytopathology (SFP), and an international Scientific Committee.

It was supported by the European Project GLIP (Grain Legumes Integrated Project), AEP, USDA, SFP, Rennes Métropole, Région Bretagne, Conseil Général, INRA 'Département de Génétique et d'Amélioration des Plantes', INRA 'Mission des Relations Internationales' and Agrocampus Rennes.

Source: B. Tivoli, F. Muehlbauer, A. Schoeny, A. Baranger, C. Le May, C. Onfroy, A. Schneider.

More information: www.grainlegumes.com (abstracts and slides) and future special issue of *European Journal of Plant Pathology.*

AEP is the EUROCROP partner responsible for grain legume crops

Acronym: EUROCROP

Full title: Agricultural Research for Improving Arable Crops Competitiveness

Coordinator: Etienne Pilorgé, CETIOM France

Partnership: 23 contractors from 10 different countries (several being European associations)

Duration: 32 months from 1 May 2006

Objective: To define a common vision of the future of research for arable crops in the EU

Web: to come – presentation at www.grainlegumes.com

One challenge for the agricultural sector is to increase or at least maintain the competitiveness of European arable crops and farming systems while maintaining high quality and safety standards within the overall framework of CAP reform (Luxembourg agreement, June 2003), and sustainable development.

The aim of EUROCROP (see inserts), a concerted action supported by the European Commission through the 6th RTD FP (*), is to bring together all concerned stakeholders and actors, to analyse the research required to improve European arable crop competitiveness, and propose appropriate action.

EUROCROP will assess the impact of CAP reform, define the possible scenarios for 2015 EU agriculture and the major indicators related to arable crop competitiveness, and propose research actions for consideration. The partnership includes both organisations providing research, innovation and extension services and those utilising the results of research such as crop chain organisations and farmers' organisations. The Project Advisory Committee is made up of stakeholders in charge of indicating the major concerns to be addressed.

To meet its goals EUROCROP will have a two-dimensional approach, first in terms of the arable crops (cereals, oilseeds, sugar beet, fibre crops, potatoes, grain legumes and maize), and second in terms of the elements of competitiveness including technical aspects at the farm level, farm economics and production costs, outlets and markets, quality of agricultural products, environmental impacts and socio-economic issues. These topics will be addressed by specialists and invited experts in a series of workshops each with a common approach.

AEP is the EUROCROP partner responsible for the coordination of activities specifically related to the assessment of grain legume crops.

The main results of this concerted action will be (i) a strategic research plan and proposals submitted to policy makers, and discussed at an open conference, and (ii) the establishment of a European network of experts, to continue work beyond this action in order to set up RTD projects. ■

(*) in Priority 8.1 – Scientific Support to Policies of the 6th Framework Programme on Research, Technological Development and Demonstration of the European Union

Source: A. Schneider (a.schneider-aep@prolea.com)

Insert

"The European Commission wishes that EUROCROP (and especially through its final conference) offers a place for discussion to enhance the exchanges between the scientific parties and stakeholders concerning arable crops competitiveness.

The EU Technology Platforms or ERA Net are instruments used for such type of concerted approach at the European level. Some address necessary components like 'Plants for the Future' (*). None is addressing competitiveness of arable crops in a comprehensive view. That is why the European Commission will welcome a proposed research agenda for competitiveness of European arable crops, as well as any analyses and tools relevant to enhance this sector and its assessment."

Mr Lutzeyer, EU Scientific Officer for EUROCROP, kick-off meeting, Brussels, 13 July 2006.

(*) http://www.epsoweb.org/Catalog/TP/docs/SRA-III.PDF

A greater role for lupins in the UK? Introducing the project LISA

Un rôle plus important pour les lupins au Royaume-Uni? Présentation du projet LISA

by Michael T. ABBERTON*

The case for lupins . . .

Yellow lupins (*Lupinus luteus*) and blue (narrow-leafed) lupins (*L. angustifolius*) have considerable potential as a component of both monogastric and ruminant diets due to their high protein content (30–45%) and metabolisable energy (ME) of 11–15 MJ/kg dry matter. The key amino acids lysine, leucine and serine are in excess of 5% total protein and methionine is greater than 1%. (reviewed in (2)).

Lupins have the capacity to play a dual role in UK agriculture. In the wetter west, where livestock farming predominates they are crimped for on-farm use. This is probably the largest current use of yellow lupins. In the drier east they are a break crop option in arable rotations, producing grain for compound feed and potentially substituting for soya meal.

. . . and the case against

However, the crop is not grown widely in the UK and there is a need for more information on its performance and possible contribution. There is also a requirement for germplasm better adapted to UK conditions.

Currently the major problem under some circumstances is unreliability of yield. Available varieties have not been bred for UK conditions and may not respond well to the stresses of the climate.

Lupins in Sustainable Agriculture (LISA)

LISA is a five-year programme carried out in the UK with financial support from the government and from industry. It is focused on the development of yellow and blue lupins as spring-grown crops in the UK.

*Institute of Grassland and Environmental Research (IGER), Aberystwyth, UK. (michael.abberton@bbsrc.ac.uk)

Its purpose is to carry out an integrated range of studies that will facilitate significant progress towards realising the potential of these species in promoting more environmentally and economically sustainable agricultural production both as an arable break crop and for on-farm feed in livestock enterprises.

Considerable research has been carried out in the UK on winter-grown white lupin (*L. albus*) (for example, (1)), but there has been very little on spring-sown yellow or blue lupins.

An integrated approach

The project, which started in April 2004, has a number of different components:

1. Agronomy

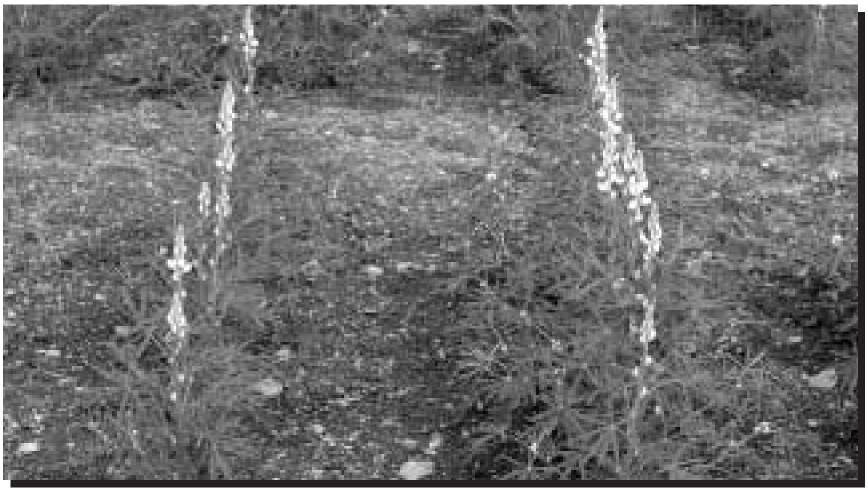
A number of field experiments are being carried out using currently available varieties, under both conventional and organic conditions. These experiments are focused on optimising crop management particularly with respect to weed suppression. They will also assess the value of lupins in crop rotations and supply grain for assessment of quality both in terms of feed value and levels of antinutritional compounds such as alkaloids.

2. Environmental impacts

Nitrogen (N), phosphorus (P) and potassium losses after lupins are harvested will be compared with losses after peas. The contribution of lupins across a rotation cycle will be evaluated in terms of both yields and diffuse pollution under both organic and conventional managements. An important aspect of the experiments involving animal feeding (see below) is measurement of nutrient use efficiency and the potential for reducing both water and air pollution.

(Photo T. Mizen, IGER, Aberystwyth, UK)

***Lupinus luteus* cv. Wodjil drills pre-flowering (stem elongation) at about eight weeks, showing differences in plant size/development between two genotypes/selections.**



(Photo T. Mizen, IGER, Aberystwyth, UK)

***Lupinus angustifolius* cv. Prima drills at flowering (about eight weeks), showing differences in plant architecture (increased branching in the right-hand-side drill).**

3. Animal nutrition

Feeding experiments incorporating lupins will be carried out on both monogastrics (pigs) and ruminants (sheep and dairy cows). These will not only study production responses (for example, liveweight gain, milk yield) in comparison with peas and soya, but also environmental impacts. In particular, N and P losses through excreta will be analysed. Taken together with field measurement of N and P balances this will allow us to carry out a broad life-cycle analysis of the use of lupins as a feed component.

Models will be developed of the contribution that lupins may make in feed formulae. Although uptake in practice is to some extent dependent on economic factors, the reliability of the crop is of crucial importance.

4. Germplasm development

The focus here is on adaptation to the UK conditions and the development of a more reliable lupin crop. In particular, phenotypic selections will be made for increased grain yield, early maturity and enhanced tolerance of alkaline soils. Molecular marker development, building on recent progress in genetic mapping in Australia and Poland (for example, (3)) will allow us to identify quantitative trait loci (QTL) for these traits and to create a package of germplasm and markers that will facilitate the development of new varieties after the end of the project. Studies will also evaluate the extent of genetic variation in important traits relating to environmental impact, in particular the efficiency of utilisation of N and P.

Germplasm improvement is effectively split into three parts dealing with determinate and indeterminate types of blue lupin and with yellow lupin. Phenotypic selections are being carried out on both individual plants in field drills and in plots. It seems likely that selection for grain yield (and hence to some extent synchronisation of pod filling) and maturity will bring about differences in plant architecture.

Technology interaction

It is important to involve all stakeholders in the development of a minor crop such as lupins in the UK. A major aspect of this project is the output of information through a range of media and discussions with farmers, seed merchants and the feed industry.

(Photo T. Mizen, IGER, Aberystwyth, UK)

***L. luteus* cv. Wodjil flower at the beginning flower elongation (about nine weeks).**

A strong partnership

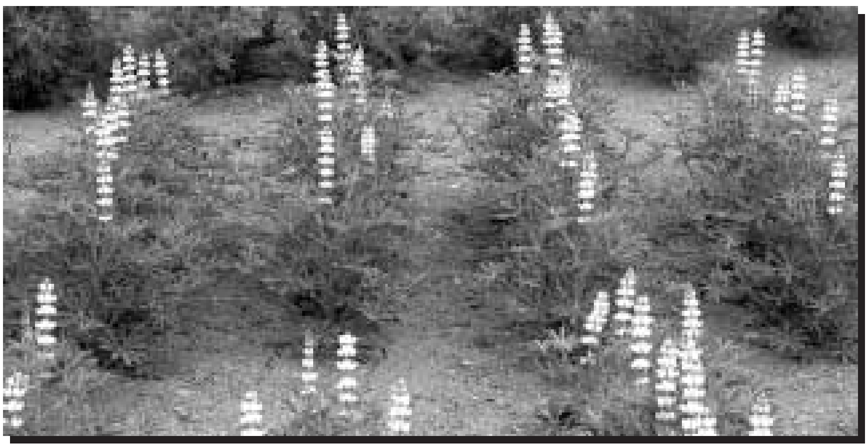
An integrated work programme such as that described above requires a range of partners, from both research and industry. A full list of LISA partners is given below[1]. It encompasses expertise in agronomy, organic systems, animal nutrition, nutrient flows and plant breeding. The involvement of industry partners (seed merchants, feed manufacturers, levy boards) is vital in leading the work towards real impact in the farmers' fields. ■

[1]LISA is sponsored by the Department for Environment, Food and Rural Affairs (Defra) through the Sustainable Arable LINK Programme. Partners: Institute of Grassland and Environmental Research (IGER) (co-ordinator), University of Newcastle, The Arable Group (TAG), Processors and Growers Research Organisation (PGRO), Germinal Holdings Limited, Associated British Nutrition and AgriProducts Limited (ABNA), Kevin Cave Limited, the Milk Development Council (MDC) and the Meat and Livestock Commision (MLC).

1. Shield *et al.* (2002). Journal of Agricultural Science **135**, 173–183.

2. Wilkins, R. J. and Jones, R. (2000). Animal Feed Science and Technology **85**, 23–32.

3. Yang, H. *et al.* (2002). Theoretical and Applied Genetics **105**, 265–270.



(Photo T. Mizen, IGER, Aberystwyth, UK)

***L. luteus* cv. Wodjil drills at flowering at about nine weeks.**

October 11–14, 2006
Plant GEMs
Venice, Italy
Web: http://www.plant-gems.org

October 25–27, 2006
Faba bean 2006
International workshop on faba bean breeding and agronomy
Córdoba, Spain
Email: anam.torres.romero@juntadeandalucia.es

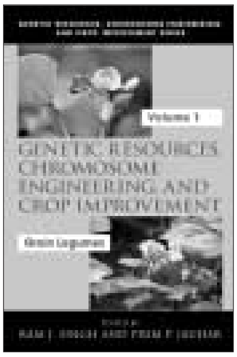
October 26–27, 2006
CIAA Congress 2006: Food for life, meeting consumers' needs
Brussels, Belgium
Web: http://www.ciaacongress.be

January 21–26, 2007
15th International Congress on Nitrogen Fixation & 12th International Conference of the African Association for Biological Nitrogen Fixation
Cape Town, South Africa
Email: aecon.e@mweb.co.za

March 24–28, 2007
2007 Model Legume Congress
Tunis, Tunisia
Email: mohamedelarbi.aouani@inrst.rnrt.tn;thierry.huguet@ensat.fr
Web: http://www.ecopark.rnrt.tn/mlc2007

September 12–14, 2007
RoS in plants 2007: a SFFR Plant Oxygen Group meeting on reactive oxygen and nitrogen species
Ghent, Belgium
Email: pog2007@psb.ugent.be
Web: http://www.pog2007.be

November 12–16, 2007
Dissemination Conference of GLIP and other legume-related activities
Lisbon, Portugal
Email: aep@prolea.com



Genetic resources, chromosome engineering, and crop improvement: grain legumes, Volume 1

Ram J. Singh and Prem P. Jauhar
University of Illinois, Urbana, and USDA-ARS, Northern Crop Science Lab, Fargo, North Dakota
March 2005, English, 390 pages
CRC Press
ISBN: 0849314305

This first volume of the series summarises landmark research and provides information on the availability of germplasm resources that breeders can exploit for producing high-yielding varieties. Written by an internationally renowned and innovative panel of scientists, the book offers the most comprehensive and up-to-date information on genetic resources and their utilisation for increasing the yield of the most widely grown and consumed grain legumes.

In eleven succinct chapters, the book focuses on the common bean, pea, pigeonpea, cowpea, faba bean, chickpea, lentil, lupin, mung bean, and azuki bean. Discussions for each crop begin with a brief introduction and then provide comprehensive information on the origin, genetic resources, cytogenetics, and improvement strategies by conventional, chromosome-engineering, and molecular-breeding methods. Primary (GP-1), secondary (GP-2), and tertiary (GP-3) gene pools for a crop are identified and their use in producing high-yielding varieties with resistance to several biotic and abiotic stresses are described as well.

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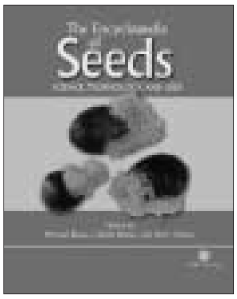

The encyclopedia of seeds: science, technology and uses

Eds M. Black, J. D. Bewley and P. Halmer
October 2006, English, about 900 pages
CABI Publishing, Wallingford, UK
ISBN 0851997236

This is the first scholarly reference work to cover all the major scientific themes and facets of the subject of seeds. It outlines the latest fundamental biological knowledge about seeds, together with the principles of agricultural seed processing, storage and sowing, the food and industrial uses of seeds, and the roles of seeds in history, economies and cultures.

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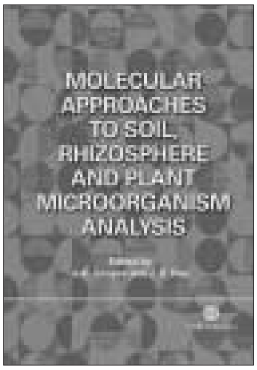

Molecular approaches to soil, rhizosphere and plant microorganism analysis

by J. E. Cooper, J. R. Rao
October 2006, English, 352 pages
CABI Publishing, Wallingford, UK
ISBN 1845930622

Many techniques are now available for analysing the microflora of soils, plants and their rhizospheres at the molecular level. They are however, widely dispersed among reports in archive journals, which makes comparison and selection difficult for a researcher embarking on a new project. This book provides a comprehensive collection of molecular methods for studying the microbiology of soil and plants at the community, population, taxonomic and functional group levels. These methods are discussed in a critical manner by experienced international authors.

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(Photo Zaven Grigoryan, Genebank NAS, Republic of Armenia)

Vetches: from feed to food?

Les vesces : vers une valorisation alimentaire pour l'homme?

Narbon bean (*Vicia narbonensis*).

In matters agricultural, it is useful to compare; the new with the ancient, the northern hemisphere with the southern, the good with the bad, the poor with the rich, the triumphs with the fiascos and to glean from all these differences, those practices that have advanced civilisations and those that have not.

In this special issue devoted to the role of vetches (*Vicia* spp.) in agriculture, we have selected examples that are ripe for a concerted effort, not just to modify their genetic composition, but to use all the skills we have as scientists and agriculturalists, to raise these extraordinary legumes to a higher plane of usage and economic value for everyone.

Our first article outlines the general approach including historical reasons why we should not believe everything we read in the papers be they by journalists or scientists. The section on global vetch production estimates their economic role. It also illustrates how a few, well chosen words in a prestigious journal like *Nature* can (eventually) stop a deceptive export industry and prepare the way for a sound and more rewarding industry.

In the common vetch (*Vicia sativa*) and the narbon bean (*Vicia narbonensis*) articles, we suggest, that modification of the antinutritional content of these two species, will not only provide us with all their inherent agronomic diversity to cope with current climatic changes, but additionally provide two immense new food sources. The final article shows how Turkey is approaching the problem of changing the short-term mindset of continuous cereal cropping with attendant disease problems, to one in which the introduction of early-maturing vetches and chicklings (*Lathyrus* spp.) can raise the productivity and financial well being of individual farmers. ■

Dossier coordinators: Dr Max Tate and Dr Dirk Enneking.

Dans le domaine agricole, il est utile de comparer, le nouveau avec l'ancien, l'hémisphère nord avec le sud, le bon et le moins bon, le pauvre et le riche, les succès et les fiascos, et à travers ces différences, de glaner les pratiques qui ont fait progresser les civilisations et celles qui ne leur ont pas été bénéfiques.

*Dans ce dossier sur le rôle des vesces (*Vicia *spp.) dans l'agriculture, en tant que coordinateurs du dossier, nous avons sélectionné des exemples qui sont le fruit d'un effort collectif, visant non pas simplement à modifier la composante génétique de leur composition mais à utiliser toutes les compétences des scientifiques, agronomes et agriculteurs pour apporter une meilleur usage et une meilleure plus-value à ces extraordinaires légumineuses dans l'intérêt de chacun.*

*Le premier article brosse le tableau général rappelant les raisons historiques du pourquoi il ne faut pas croire tout ce qu'on lit dans les écrits, qu'ils soient de journalistes et de scientifiques. Ensuite la présentation de la production mondiale de la vesce permet d'évaluer son rôle économique. Elle illustre aussi comment quelques mots bien choisis dans un journal prestigieux comme *Nature *peuvent (éventuellement) stopper une industrie exportatrice illusoire et préparer le terrain pour une industrie plus cohérente et rentable.*

*Par ailleurs, nous analysons pourquoi la modification de la teneur en facteurs anti-nutritionnels de la vesce commune et la vesce de Narbonne va non seulement nous faire profiter de leur diversité agronomique inhérente pour faire face aux changements climatiques, mais également nous pourvoir de deux nouvelles sources alimentaires pour l'homme. L'article final montre comment l'approche utilisée en Turquie, pour passer de considérations à court terme favorisant les monocultures de céréales avec les problèmes de maladies qui les accompagnent, à l'introduction de vesces à maturité précoce et de gesses (*Lathyrus *spp.), permet d'améliorer la productivité et la qualité de vie des agriculteurs.* ■

SPECIAL REPORT
VETCHES: FROM FEED TO FOOD?

Vetches: from feed to food?

Les vesces : vers une valorisation alimentaire pour l'homme?

by Max TATE* and Dirk ENNEKING**

Food, feed or weed? Vetches can be all of these things, to nearly all people, depending on the time and the place. To simplify the following series of articles we have limited our discussion to annuals of the genus *Vicia*. This excludes its perennials and vetches in the genera *Lathyrus* and *Astragulus*. To delineate the topic range, we have restricted it to Europe and Australia. We realise that this dossier can only provide a brief introduction to the tremendous treasure of information, which has accumulated since antiquity for these crops and potential domesticates.

We believe that some vetches can be developed in a way similar to that used for lupins in the 1920s (6) and are interested in their improvement to the stage where they become suitable as pulses (soup legumes) for use by vegetarian societies in particular.

A 'career path' for vetches

History tells us that the standard progression of any species of *Vicia* in agriculture is its initial use as a producer of biomass, or its recognition as a contaminant of other crops. From there, it evolves to fill various niches, as a desirable crop plant or a persistent nuisance. Due to a potent mix of antinutritional factors in various parts of the plant, its use as a feed tends to be restricted to ruminants, although pigeons are often cited as being fond of vetch seed.

The greatest obstacle in the hypothetical 'career path' from vetch to pulse, is the presence of non-protein amino acids and other heat-stable antipredator toxins, that have evolved in the seeds.

Versatilility for farmers

The economic importance of vetches is based on their versatility for farmers and the immense diversity of available germplasm that underpins their widespread adaptation (3). From acid (*V. villosa, V. articulata* Hornem.) to alkaline soils, dry to waterlogged, autumn or spring sowing, the different species with their genetic variation offer considerable latitude to cultivators. The best soils for vetch are well-drained (not water-logged), lime containing, clay and loam soils. Sandy soils are, with some exceptions, such as *V. villosa*, less suitable (2, 3). Biomass and seed production, abiotic- and biotic-stress tolerance, management flexibility and low input requirements are the principal attributes that have attracted farmers throughout the ages to grow vetches. The available data for vetch production around the world is discussed in one of the following articles to provide an economic perspective.

The high nitrogen fixing ability of *V. villosa* (1) gives reason to think about this trait as a specific breeding objective for other legume crops, which have been domesticated for much longer (5).

The breeding of vetches, was last reviewed in detail by Lechner (4). Cultivars were developed for several species and much of this 'enhanced germplasm' has found its way via national genebanks, such as the important vetch collection in Gatersleben, Germany, into international collections, where their cultivar status is not always recognised. Hence any claims of breeding successes with so-called 'wild' *Vicia* germplasm may need to be revised once the original source(s) of germplasm can be ascertained, if necessary, by follow up of donor information and molecular phylogenetic fingerprinting techniques.

(Photo CRIFC, Ankara, Turkey)

Pre-basic seed production of hairy vetch (*Vicia villosa* ssp. *villosa* variety Selcuklu 2003) at the Central Research Institute for Field Crops (CRIFC), Ankara, Turkey.

*University of Adelaide, School of Agriculture, Food and Wine, Glen Osmond, SA 5064, Australia. (max.tate@adelaide.edu.au)

**Centre for Legumes in Mediterranean Agriculture, University of Western Australia, Nedlands WA 6907, Australia. (enneking@cyllene.uwa.edu.au)

(Photo CRIFC, Ankara, Turkey)

Narbon bean (*Vicia narbonensis*).

Mansfeld's database in Gatersleben (http://mansfeld.ipk-gatersleben.de/) lists 17 cultivated *Vicia* taxa, with use for fodder [7], forage [12], animal feed [3], experimental purposes [7], famine food [1], food [8], pasture [11], pasture crops [3] and scientific use (lectins) [1].

Some of these were never taken into commercial production, but repeated attempts were made during the nineteenth century, and these efforts demonstrate the continual efforts to harness the productivity of wild and weedy vetches for agricultural purposes. The large number of species listed for food use (apart from *V. faba*) may need some adjustment.

There is good historical evidence that in times of famine, our ancestors turned to these nitrogen rich legumes with 20–30% crude proteins (in *Vicia* from 2–7% of this 'protein' actually consists of non-protein amino acids) to nourish themselves and their livestock. For example, Philostratos describes how Apollonius came to the town of Aspendus in Pamphylia where he found nothing but vetch (Orobos = *Vicia ervilia*) on "sale in the market, and the citizens were feeding upon this and anything else they could get; for the rich men had shut up all the corn (cereals) and were holding it up for export from the country". Clearly, food substitution with vetches has had a long record but detoxification would have had a significant role to render such famine foods edible. In Hellenistic Egypt specific vetch sellers existed, presumably to carry out the leaching and detoxification business.

Livestock losses through vetch toxicity: recent domesticates

Livestock intoxication by vetches continues to be reported. The main vetch species implicated are *Vicia villosa* and *Vicia benghalensis,* both recent domesticates and characterised by high levels (2-3%) of the toxic amino acid L-canavanine in their seeds. From the onset of flowering onwards, the levels of this arginine analogue increase and make the utility of these crops as feeds, in the absence of alternative fodder sources, a risky business. In contrast, ancient crops such as *V. ervilia* have very low levels of canavanine in their seeds, but for this species chemically uncharacterised , water soluble bitter components require leaching prior to any possible food usage. Common vetch (*V. sativa*) can be cyanogenic and contains some additional toxins in its seeds. A separate article in this dossier provides an update on the development of non-toxic strains. The cyanogenic strains have frequently been implicated in stock losses. Generally, such losses occur more frequently when vetches are introduced as novel crops into new areas and new uses. Clearly, extension agents can learn a lesson from this but more research is also needed to identify optimum management practices to prevent further intoxications by canavanine type vetches. For details see reference (7) on page 19.

High levels of sulphur amino acids, the flavour of narbon beans

The narbon bean (*V. narbonensis*) has had, and continues to have a chequered history as far as its acceptance, either as feed by animals or food by humans, is concerned.

The narbon article in this vetch series reveals observations made by early European botanists and how this provided some clues to modern research. It also notes the extraordinarily high levels of sulphur amino acids in the seeds of narbon beans and why we consider it is worthy of closer investigation by all investigators.

There is considerable interest in the narbon bean in Turkey (see pages 20–21) and it has not been entirely overlooked as a potentially useful crop in rotations in Western Australia and Spain. In part, this renewed agronomic interest in narbon bean, is centred upon its remarkable tolerance to abiotic and biotic stresses.

The very real possibility, that the toxic famine food known as common vetch, can have its cyano-alanine toxin level reduced to a level that is tolerable to poultry, which are the most sensitive indicators, is being actively investigated in Turkey and Australia and is discussed on pages 16–17. Given that it took several decades to convert the toxic rapeseed into what is now known as Canola, we are of the opinion that there are good prospects for doing the same thing with *V. sativa* even though considerable research effort is still required.

However, the short-term nature of political and corporate memories revealed in some of these vetch items, inevitably leads to repetitive mistakes in their usage. Fortunately, the clarity of hindsight afforded by better statistics in agriculture, show us what have been sensible and what have been foolish ventures in global vetch production. The occasional historical perspective as exemplified in the narbon article, can also provide unexpected enlightenment and provide clues to important work, which still needs to be done, so that these frequently neglected, but inherently valuable legumes, can provide us with plan 'B' to handle both biotic and abiotic stresses caused by the approaching climate changes that lie ahead. ■

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Global vetch production

La production mondiale de vesces

by Dirk ENNEKING* and Max TATE **

Vetch in the strictest sense is *Vicia*. Commercially this comprises *Vicia sativa* (common vetch) and *Vicia villosa* (Winter vetch, hairy vetch), with some species having local significance such as *V. pannonica* in Turkey, *V. ervilia* and *V. articulata* Hornem. in Spain and *V. benghalensis* in Australia. It is instructive to compare different data sources and make a distinction between production and uses. Even the term 'vetch' sometimes refers to an entirely different species in Africa.

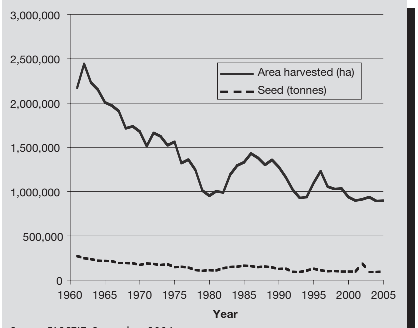
For example, before the Second World War, Fischer (1938) sketched a picture of vetch production in Europe. Countries like Germany, Austria, Bulgaria, Lithuania and Spain cultivated vetches as grain- and fodder crops. In Great Britain, Hungary, Yugoslavia, the Netherlands and Sweden, vetches were only cultivated as green forage. In Czechoslovakia they were mainly cultivated as grain crops. Germany in 1937 produced 132,321 ha of vetches (4).

Vetch production in Eritrea and Ethiopia refers to the cultivation of grasspea (*Lathyrus sativus*), a different species entirely! Data from other countries may include this and other species such as *L. cicera*, *L. tingitanus* or *L. ochrus*.

Significant under-reporting

Production statistics for vetches from FAO (Figure 1) supposedly indicate a global decline in vetch production (area harvested) since the 1960s.

A closer look at data from individual countries suggests that significant areas of production are under-reported or amalgamated under other headings such as animal feed (forage) and pulse production (dry seed). For example, since 2002 no separate vetch production data has been recorded for Australia. For the USA, where *V. villosa* is a widespread catch crop and is even used in preference to plastic as a mulch for 'power tomatoes', vetch production does not feature at all during the 45 years covered by FAO records. Neither are there any figures from China under this category.



Source: FAOSTAT, September, 2006

Figure 1. Global vetch production (area harvested).

A comparison of FAO production figures (area harvested) for the years 1961 and 2005 reveals that there are some countries in which reported vetch production has remained stable (Turkey, Lebanon, Albania and Syria), several with a precipitous decline (Bulgaria, Greece, Cyprus, former Czechoslovakia, Poland, Algeria), others with roughly a quarter of former production (former USSSR, former Yugoslavia, Italy, Malta) and even some with substantial increases (China, Spain, Australia).

According to these figures, the largest decrease (1.13 million ha) has occurred within the area of the former USSR. Vetches are well adapted and native to the Central Asian and Caucasian republics, so it is highly likely that production from these countries is presently under reported. Therefore not all of the former USSR vetch production has necessarily been lost, it is just not being adequately reported.

For China some information can be gleaned through Google. In 1998 *V. villosa* was cultivated on 124,000 ha and *V. sativa* on 99,000 ha (6). This puts China into the top ranks of vetch producing countries. Anyone driving through Yunnan province during spring can witness the widespread cultivation of *V. villosa* because purple flowered fields are aplenty on a drive south-west of Kunming.

Dramatic increase in Australia

Figure 2 shows that Australian vetch cultivation, increased dramatically after the early 1960–80s plateau. This came about through Australian agricultural experts returning from Jordan, where they were meant to introduce the ley farming system based on medic and clover cultivation. The Jordanian farmers were not that impressed with the idea of planting something that was so close to the ground that it did not look like a crop and hence under their customs permitted everyone to graze their flocks on it.

In Jordan they preferred to grow vetch crops that could be grazed only by permission and so no fences were needed. With everyone adhering to these customary taboos, feed production was just fine. The Australian advisers were so impressed with the vetch productivity in Jordan that they promoted such cultivation in their homeland (2). Luckily, other visionaries had preceded them by several decades so that they could draw on cultivars already released during the 1950s by Eric Bailey of CSIRO at Muresk, Western Australia.

A cultivar with orange cotyledons

Among Bailey's releases, was one cultivar (Blanche fleur) with orange cotyledons which when split closely resembled red lentils. Figure 2 shows that from the late 1980s, the gold rush was 'on', primarily

*Centre for Legumes in Mediterranean Agriculture, University of Western Australia, Nedlands, WA 6907, Australia. (enneking@cyllene.uwa.edu.au)
**University of Adelaide, School of Agriculture, Food and Wine, Glen Osmond, SA 5064, Australia. (max.tate@adelaide.edu.au)

due to Blanche fleur vetch exports for sale as a cheap substitute for red lentils, consequently production dramatically increased. The two sharp collapses of the Australian vetch harvest after 1992 and again in 2000 (Figure 2) correlate perfectly with two articles in *Nature* in October 1992 and July 1999 that drew attention to the folly of the continuing export of red split vetch as a cheap substitute for red lentils (see also page 16–17).

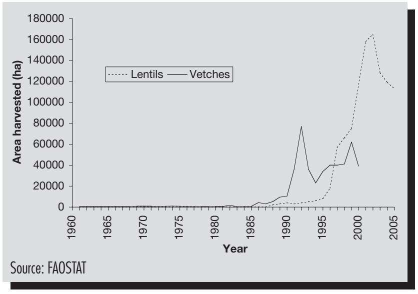


Figure 2 Areas of lentils and vetches harvested in Australia between 1960 and 2005.

With the aid of a ban on split vetch exports in 2003 to protect lentil exports, sanity returned, and since then the area of vetch cultivation has remained significant and currently (2006) appears to be expanding more and more into hay production due to the release of successful rust resistant *V. sativa* cultivars such as Morava. The current estimated area for South Australia is 25,000 ha, and in the south-eastern state of Victoria a larger amount is grown, perhaps 50,000 ha, in what was originally 'Mallee' (a type of eucalypt tree) country. Adding New South Wales, Western Australia and Tasmania, the total area sown to vetches easily exceeds 100,000 ha. One vetch report suggests an estimated area of more than 250,000 ha for the past five years. It remains to be substantiated whether this is a cumulative or an annual figure. The 2006 Australian census data should provide the correct figures.

Spanish statistics reveal political intervention

A second example demonstrates how more reliable statistics can provide an interesting hindsight picture of political intervention. The detailed production figures for individual species are available from Spain (8) from 2004 and are plotted in Figure 3. The cumulative figure of 281,940 ha for Spanish vetch production in 2003 does not match with the FAO reported harvested area of 166,600 ha. In addition, the Spanish Ministry of agriculture, fisheries and food (MAPA) provides details on vetch forage production in 2003 (59,700 ha) (8).

It is not clear whether the area for vetch forage is included in MAPA's production figures for individual grain legumes species, or whether they should be added. If added, the total vetch production for 2003 would be 341,640 ha. However, it is clear that forage cultivation in Spain has declined steadily between 1990 and 2003.

The remarkable peak in the area sown to *V. sativa* in Figure 3 is readily understandable, once the political imperatives are taken into account. Production of vetches in the EU has received financial support since 1996. In 1989, EEC regulation No. 762/89 provided support for grain legumes. It was extended by Regulation (EC) No. 1577/96. A maximum guaranteed area (MGA) is subsidised outside of the arable crops scheme. Regulation (EC) No. 811/2000 divided the MGA between chickpeas and lentils (human consumption) and vetches (animal feed). This translates into aid of €181/ha and a MGA of 160,000 ha for chickpeas and lentils and 240,000 ha for vetches. Proportional adjustments to paid subsidies are made according to MGA size, after the combined area has been exceeded. The area for vetches was quickly exceeded. For example, in 2002/03 it amounted to 315,000 ha and consequently payments were reduced to €150/ha (3).

Eligibility for single farm payments

The common agricultural policy reform of 2003 has brought changes to these support schemes. Vetches are now eligible for the same single farm payments as for other forms of production. Since with the previous scheme, the area of production was exceeded it is now likely that the seeded area for vetches may increase again (1)

In the USA, vetch seed production was 1800 t in 1987, 2600 t in 1992, 600 t in 1997 and 270 t in 2002 (5). Depending on the seeding rate (30–70 kg/ha), the seed produced in 1997 would have been sufficient to sow 40,000–90,000 ha. The upper figure approximates to a separate estimate of 100,000 ha for vetch production in the USA, with the main areas in the Pacific Northwest, Midwest, South and Southwest (7)

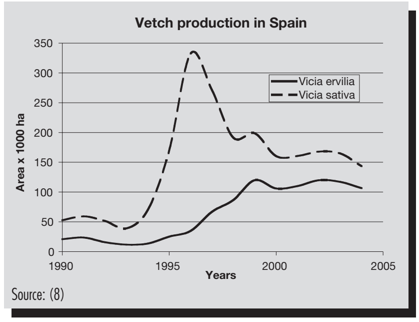


Figure 3. Vetch production in Spain.

Global seed production for vetches has been estimated at 16,197 t for 2005 (5)

So from all these under-reported statistics, it is immediately clear that plots such as Figure 1, must be looked at with considerable skepticism!

In conclusion, the adjusted figure based on the discussion above for the global area of harvested vetches is 1.25 million ha. This is 58% less than in 1961 and most likely a less than fair proportion of actual global vetch cultivation. Vetches as a group are still a significant global crop. ■

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SPECIAL REPORT
VETCHES: FROM FEED TO FOOD?

Common vetch (*Vicia sativa* ssp. *sativa*): feed or future food?

La vesce commune (Vicia sativa ssp. sativa) : pour les animaux ou demain pour l'homme?

by Max TATE* and Dirk ENNEKING**

Common vetch has small seeds generally 20–90 mg, with a protein range of 240–320 g/kg. However, like most legumes it has evolved a range of nitrogenous antinutritional factors (ANFs), (β-cyano-L-alanine, its γ-L-glutamyl peptide, the cyanogenic glycosides vicianine and prunasin, and also the favism toxins vicine and convicine, that are common to faba bean). The total N content is boosted by these components.

ANFs are a major constraint for monogastric consumption

As in the case of narbon bean, it is the ANFs of common vetch, that are the major constraints to its use as a monogastric feed stuff or in some circumstances as a famine food. Otherwise it is a very useful grain legume. Thanks to an early quantitative study of cyanogens (5), it is known that one well-adapted line, Blanche fleur, grown extensively in Australia, is devoid of the cyanogenic glycosides. It does, however, have a significant (1.3–1.6%) cyano-alanine toxin content.

The major collection of germplasm for economically important *Vicia* is held at ICARDA, Aleppo Syria (14). The ICARDA germplasm data used for Figure 1 shows that in both *V. sativa* ssp. *sativa* and also ssp. *nigra* accessions, there is an inverse function between seed size and cyano-alanine toxin content, as measured by diffuse reflectance infrared spectrometry (2). The more toxic subspecies *nigra*, is characterised by much smaller seeds (10–60 mg).

*University of Adelaide, School of Agriculture, Food and Wine, Waite Campus, Glen Osmond, SA 5064, Australia. (max.tate@adelaide.edu.au)

**Centre for Legumes in Mediterranean Agriculture, University of Western Australia, Nedlands, WA 6907, Australia. (enneking@cyllene.uwa.edu.au)

Is a common vetch seed with zero cyano-alanine toxin possible?

Figure 1 plots more than 1,600 accessions (*V. sativa* ssp. *nigra* (156) and ssp *sativa* (1457)), with paired values of 1000-seed weight (g) (= average seed mass (mg)) and % cotyledon cyano-alanine toxin content. The significant (<0.0001) negative correlations for both *V. sativa* subsp. *sativa* and subsp. *nigra* can probably best be accounted for by assuming that some accessions have a fixed amount of toxin per seed, and that this toxin is diluted gradually in accessions with larger seed masses.

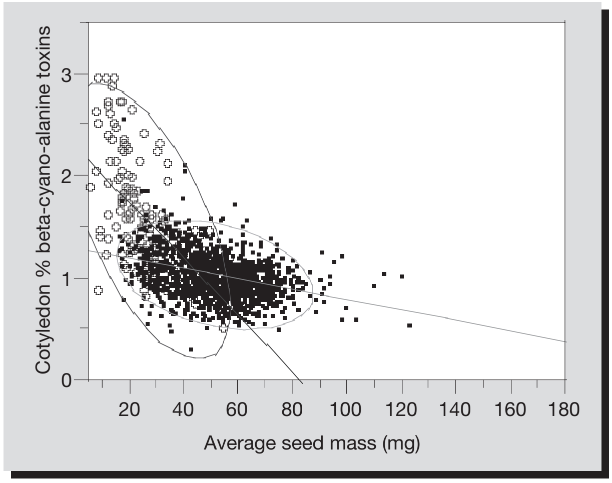

Figure 1. Bivariate normal ellipses (*P* = 0.950) of the average seed mass (mg) *vs.* the cotyledon % cyano-alanine toxins of 156 accessions of *V. sativa* subsp. *nigra* (open circles) and 1457 accessions of *V. sativa* subsp. *sativa* (squares) sourced from ICARDA, Aleppo, Syria.

Figure 1 shows that although not one genuine, zero cyano-alanine toxin, *V. sativa* accession was found, it also suggests the intriguing conclusion, that a near-zero % cyano-L-alanine toxin cultivar, might be obtained from the cross of a small seeded *V. sativa* ssp. *nigra* with a large seeded *V. sativa* ssp. *sativa*. F2 seed, that has been grown by H. Firincioglu in Turkey, to test this hypothesis will be analysed shortly.

The importance of minimising the content of cyano-alanine toxin in common vetch especially for feeding monogastric animals, stems back to the pioneering work of Ressler in the 1960s (6) and again later (7). Another study of antinutritional as well as synergistic effects observed in poultry fed with common vetch was published by Farran *et al* in 2001 (4).

Red split vetch/red lentil substitution has been stopped

Because of the similarity in appearance of the split orange cotyledons of some accessions (for example, Blanche fleur), to the cotyledons of the red lentil (*Lens culinaris* Medik), there have in the past, been repeated attempts (12, 13) to substitute red split vetch for the red lentil in third world markets. In 2003, the Australian government, made it a criminal offence to export split vetch, and the vetch/lentil substitution problem has apparently ceased. An indirect benefit from the demise of the vetch for food export industry is that Australia is now the third largest exporter of the highly valued, genuine red lentils, in the world (3).

Recent pig experiments

The adverse effects of some *V. sativa* accessions to poultry, ducks and pigs are well known, but recently, a well-controlled experiment, with 312 male pigs, (1) has demonstrated that one Australian *V. sativa* cultivar, Morava, could be fed to grower pigs at levels up to 225 g/kg of the diet without serious effects on growth performance being observed between 91 and 118 days. However, a significant negative linear response was observed between 119 and 161 days with a measurable voluntary feed intake decrease from 2.62 to 2.44 kg/day. Dietary differences due to the meat–meal content may have been a contributing factor to this decrease.

Unfortunately, no measurements were attempted on the cyano-alanine toxin content, either of the diet or the pig livers. Independent measurements in Adelaide with West Australian 2004 and 2005 samples of Morava vetch, gave cyano-alanine toxin contents for the cotyledons of 10.4 +/– 0.8 g/kg (mean +/– s.d.) and 9.7 +/–0.8 g/kg, respectively.

Although it is not possible to link the cause of the observed voluntary feed inhibition during the latter stages of the pig feeding trial to the cyano-alanine toxin content alone, any decrease in feed intake is a definite antinutritional factor warning sign for those promoting common vetch for human consumption.

Possible adverse effects

Confirmatory evidence for the neuro-toxicity of the cyano-alanine toxins has been provided (9). Currently the only report, of human cases of spastic paraplegia, induced in malnourished individuals, was that described by Shah in 1939 to the consumption of *V. sativa* seeds, present as contaminants in samples of stored wheat (10). This rather dated paper is important, because of the care taken to obtain an authoritative botanic opinion from Lahore, in order to properly identify the assumed causal agent as *V. sativa* alone.

There are two recent publications from the Ressler laboratory, concerning the antinutritional components of common vetch. The first (11) deals with the content of cyanogen, vicine, and beta-cyano-alanine toxins in a common vetch food, and their removal. They are essential reading for anyone wishing to use common vetch as either feed or food. It is noteworthy for drawing attention to the possible adverse synergistic effects due to cysteine sulphur depletion by the content of cyano-alanine toxins and cyanogens. The second (8) deals with urinary excretion of thiocyanate in a rat model. These studies suggest that all animals consuming sulphur deficient diets are likely to be affected adversely by the combined effects of sulphur depletion *via* thiocyanate and cystathionine excretion, induced by the consumption of toxins in common vetch.

Unless it can be demonstrated unequivocally that proteinaceous factors are also important, the literature to date suggests, that to produce a successful monogastric feedstuff from *V. sativa*, both the cyanogen and the cyano-alanine content must be minimised and excessive sulphur loss, induced by any residual vetch toxins, should be compensated for. Success with these objectives, could lead to the rapid adoption of low-toxin cultivars of common vetch, which are bred specifically for pig nutrition. For poultry nutrition, minimisation of the favism toxins vicine and convicine must also be achieved.

An enormous potential, monogastric feed and food source

As is apparent, from the article on the global production of vetches on page 14, there are enormous areas, already allotted to common vetch throughout the world, that are currently used primarily for forage, haymaking, green manure and as a grain feed for ruminants. These data, suggest that there will be an equally enormous feed resource for monogastric animals, once the content of antinutritional components has been minimised.

It is already well established that poultry are the most sensitive indicators for vetch toxicity (4, and references therein). However, for commercial feedstuffs where lowest cost formulations are practised, it is generally not economically feasible to use costly, small-scale post-harvest treatments such as extraction and autoclaving to produce a useful high quality feedstuff. The only practical recourse is to reduce permanently the levels of antinutritional factors by suitable plant breeding strategies.

The goals for useful cultivars, which also means well adapted lines of low toxin *V. sativa*, that provide high yields (>2 t grain /ha) and are suitable for monogastric consumption, are now clearly defined. Exactly which is the best and fastest way to get there, either by screening the products of classic plant breeding from the glasshouse and the field or alternatively the screening of genetic modifications produced in a Petri dish, followed by growth chamber experiments and ultimately by field experiments, only time will tell, and markets will decide. There is clearly a lot of plant breeding work to do in the years ahead.

The experience from the 1960s in Canada, with the production of lines of rapeseed, which also minimised two toxins (erucic acid and glucosinolate) to provide us with canola, shows us exactly what can be done. ■

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Narbon bean (*Vicia narbonensis* L.): farmer's dream or devil's bean?

La vesce de Narbonne : le rêve de l'agriculteur ou la fêve du diable?

by Marina Arias ROYO*, Max TATE* and Dirk ENNEKING**

Narbon bean, mouse vetch, moor's pea, or devil's bean, are all common names (8) for this intriguing vetch species (*Vicia narbonensis* L.) which has an upright growth habit and is well adapted to Mediterranean and adjacent climatic regions (2). It was formerly believed to be the progenitor of the faba bean (*Vicia faba* L.) but molecular studies have refuted this idea.

Different botanical varieties are differentiated primarily by seed size. Both *V. narbonensis* var. *aegyptiaca* and var. *narbonensis* seeds could easily be mistaken for peas. The larger var. *aegyptiaca* types have been found in Turkey near Tunceli, in Lebanon in the Bekaa Valley and in Andalucia, Spain. Sicily and southern Italy are sources for agronomically interesting var. *narbonensis* types (7, 8). In Spain, narbon bean was largely neglected for a long period and is now found only in certain areas in Extremadura, Castilla La Mancha and Andalucia. However, thanks to recent studies there has been a revival of Spanish interest in this neglected crop.

Some agronomic virtues?

In the 1980s an Australian agronomist, David Georg championed the species as a potential new grain legume for dryland cropping. Ali Abd El Moneim and colleagues at ICARDA screened the available germplasm for grain and forage production in the Middle East and North Africa. A small-seeded variety IFVI 67, originally collected from Arbil in northern Iraq by Barry Bull and colleagues continued to give astounding agronomic performances under adverse conditions. Other promising material, originally collected by Geoffrey Hawtin, originated from a single population in the Bekaa Valley. In Spain during the drought of 1992, 900 kg seed/ha were harvested in Castilla y León, when all other legumes were close to zero yield. Seed yields of some varieties exceeded those of peas (4, 12 and references therein). Cultivars Gran Velox and Gran Veliero have recently been released in Italy and cultivar Tanami in Australia.

Has it been a food?

In Belgium, Dodoens (1583) noted if the seed is chewed, "it filleth the mouth full of stinking matter". However, Camerarius (1586) described the taste of the seed as similar to broad beans. The picture depicted by Camerarius appears to be of *V. narbonensis* var *aegyptiaca*. In accord with Dodoen's view, the Arabic name for the narbon bean, is Habb Adh-Dhurât (devil's bean). In Australia, the German botanist Baron von Mueller (1881) advocated the use of *V. narbonensis* as food. He found the seeds to be "preferable to *V. faba* because the somewhat smaller seeds were less bitter". In the light of current knowledge this may reflect the low seed levels of the bitter favism glycosides vicine and convicine. In eastern Turkey plants are pulled from lentil fields and their seeds are included in stews or chewed as a snack when green. However, overall, the human consumption of narbon beans and related species is sporadic and of no commercial significance (7, 8).

Definitely used as an animal feed

Mateo-Box (11) provides a comprehensive account of *V. narbonensis* as a crop plant in Spain. The grain was crushed and fed to cattle, especially calves. There are some issues with milk taint and initial feed intake (see (7) or (8) for detailed translation). There are frequent references to grazing animals (sheep and cattle) not being too fond of narbon plants and seeds, with evidence for selective feeding on preferred plant parts (6). So it is not only humans who are fussy about consuming it. A lowered palatability may be a good thing for the feeding of maintenance rations during droughts and to prevent bird or mouse damage; for animal production dependent on rapid growth rates (e.g. lambs), narbon beans would need to be made more palatable (10). Similar to the well known story of favism in humans, an intriguing link exists between the genetic makeup of the red blood cells of some sheep races, particularly those selected for wool production, and their susceptibility to sulphur containing feeds such as kale (*Brassica*) (see 7 for details). Does the palatability of narbon beans to sheep follow a similar pattern; are some breeds less tolerant than others?

Future potential?

In times of imminent climate change, it is timely to stimulate wider scientific interest in this remarkable plant. It is noteworthy that, with the exception of

*University of Adelaide, School of Agriculture,Food and Wine, Glen Osmond, SA 5064, Australia. (marina_arias@hotmail.com, max.tate@adelaide.edu.au)

**Centre for Legumes in Mediterranean Agriculture, University of Western Australia, Nedlands, WA 6907, Australia. (enneking@cyllene.uwa.edu.au)

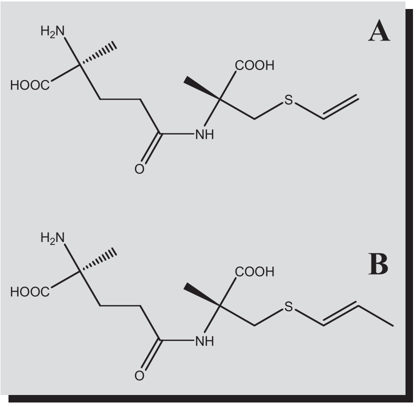

Figure 1. Structure A. The narbon off-flavour precursor (gamma-L-glutamyl-S-ethenyl-L-cysteine), Structure B. The chives seed aroma precursor (gamma-L-glutamyl-S-propenyl-L-cysteine).

some lupins, virtually all other legumes are low in sulphur; the narbon bean with a range between 2.8–3.6 g/kg total sulphur, is not.

One reason for this anomalous sulphur condition and low palatability is now known to be the presence of high concentrations (4–38 g/kg) of the 'garlic-like' stench precursor γ-glutamyl-S-ethenyl-L-cysteine (GEC) (9). The chemical structure (Figure 1A) of this apparently disadvantageous antinutritional factor, suggests to a chemist that it is ripe for the intelligent conversion to a high value-added feed or even a food crop, either by post-harvest acid treatment, to convert it to γ-glutamyl-L-cysteine and the volatile acetaldehyde, or alternatively, by replacing the gene for the S-ethenyl substituent of the narbon stench factor, (Figure 1A) with the corresponding biosynthetic gene for the aroma precursor present in the seeds of the chives plant (*Allium schoenoprasum* L.), which has a closely similar structure (Figure 1B). The only difference between the stench precursor and the aroma precursor is that the terminal hydrogen atom is replaced by a methyl-substituent. Ideally, a genetic modification should aim at converting GEC into a nutraceutical for the delivery of cysteine and not just a more tolerable flavour, since the palatability of high concentrations of the chives flavour precursor, would not necessarily be acceptable to consumers.

Using the knowledge about GEC in Australia, the available germplasm was screened to find genotypes with lower seed levels of this compound (5). Field trials with promising genotypes showed that soil sulphur levels can have a dramatic influence on seed levels of GEC and that not all the sulphur correlated with GEC (3), presumably due to premature ripening and accumulation of sulphate. A cultivar, Tanami, with somewhat reduced GEC levels was released and is now finding its niche in the Salmon Gums area of Western Australia.

What needs to be done now?

The high concentrations, of the S-substituted-cysteine in the seeds of narbon beans are both an obstacle and an opportunity. One approach is to get rid of GEC through selection. The other is to modify the biosynthetic pathway to enhance the nutritional value of the sulphur pool stored in GEC. A transformation protocol developed for the species by Thomas Pickardt (FU, Berlin) is available. Now, the tissues and sub-cellular compartments where GEC and its precursors are made need to be identified and the enzymes examined in detail. Dimitri Demidov (IPK, Gatersleben), Sabine Gillandt and Martin Meixner (FU, Berlin) have made some progress in locating tissues other than seeds where GEC can be detected in the plant.

For any successful plant-breeding programme it is essential, that a suitably fast and accurate non-extractive analysis be developed. Diffuse reflectance near infrared (NIR) is ideally suited for plant breeding purposes, and a suitable extractive analytical procedure for cross validating an NIR calibration curve has recently been published (1). Once this NIR analytical facility is widely available, it is predictable that a marketable narbon bean feed stuff could be developed from diversity generated through hybridisation or mutation. Careful control of soil sulphur levels during the selection progress will be essential.

Alternatively, development of a cheap post-harvest hydrolysis method to take advantage of the extremely high levels of GEC found in some accessions, could produce a valuable high cysteine feed stuff, thereby remedying the continual problem of the low sulphur amino acid content in most grain legumes.

It is important to evaluate whether the well-recognised ability of the sulphur atom to prevent free radical damage by sequestering oxygen free radicals, as exemplified by the use of thiourea to assist the germination of old seeds, is also correlated with the narbon bean's high GEC content and tolerance to both abiotic and biotic stresses. With the development of narbon bean varieties, that are both rich and poor in their GEC content, the opportunity arises to examine whether there is a positive correlation between a plant's GEC content and its ability to tolerate abiotic and biotic oxidative stresses. Such a discovery would provide a major step forward for agriculture.

Thus the much maligned and ill-regarded narbon bean could then be seen in a more positive light, as a gene reservoir for GEC-related traits, which might confer adaptability to a wide range of environments and as a model for crop improvement in general. ■

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Vetch production in Turkey

La production de vesces en Turquie

by Huseyin Kansur Fırıncıoğlu*

Livestock production in Turkey puts high grazing pressure on natural pastures and is limited by the quality of its rangelands. Principally, the rehabilitation of these grazing resources is designed to foster roughage production, and the introduction of forage species into crop rotations is to improve feed resources. However, with the large livestock population and the reliance on natural pasture production, range rehabilitation is almost impractical, and therefore improving forage cultivation in cropping systems is crucial. To increase feed legume production, the introduction of forage crops into cereal and industrial crop (cotton, sugar beet, sunflower) rotations is essential. The major cultivated feed legumes, are common vetch (*Vicia sativa*), Hungarian vetch (*V. pannonica*), bitter vetch (*V. ervilia*), field pea (*Pisum sativum* ssp. *arvense*) and grass pea (*Lathyrus sativus*). Potentially important ones are hairy vetch (*V. villosa* ssp. *dasycarpa*) and narbon bean (*V. narbonensis*).

Vetch crops can also be grown alone as pure stands either for grain and straw, or for hay production in mixtures with crop species such as barley, oats and rye.

(Photo CRIFC, Turkey)

Variety yield trials of some annual forage legumes (grass pea and vetches) at CRIFC Research Station near Ankara.

*The Central Research Institute for the Field Crops (CRIFC), Ulus/Ankara, Turkey. (huseyin@tr.net)

Moreover, they can be grazed alone as short-term pastures. It is this versatility, which has led to an expansion in vetch production without any decline in the area of the main crops through appropriate short-term crop rotations.

In rainfed inland regions

In Turkish dryland farming systems, the cereal–fallow cropping pattern is still widely practised. In Central Anatolia, in place of the fallow, Hungarian vetch is now grown as a winter crop, and common vetch is used as a summer crop. When grown in a mixture with cereals they produce good quality hay. Various experiments conducted in the Ankara and Çorum Provinces of the Central Anatolian Region revealed that annual forage legumes can be grown successfully either alone or in mixtures with a companion cereal crop (17, 18). In Eskisehir Province, annual forage legumes, grown for herbage, did not cause any yield losses of the following wheat (10, 12). However, for seed production, some losses in subsequent cereal grain yield were attributed to a lower accumulation of nitrogen in the soil and to reduced amounts of water in the soil profile (10, 12).

In humid and sub-humid coastal regions

The beneficial effects of forages in rotations have been established unequivocally for both moist areas and under irrigation. In coastal areas, vetch forages can be used advantageously as a second crop in rotations in (a) winter from November to April, and (b) summer from May to October. In the humid coastal areas, wheat, barley, oats and rye are the main winter crops and maize, sunflower, tobacco, soyabean, sugarbeet, cotton and potato are the main summer crops. If the cereals are grown as the main winter crop, then after their harvest, silage maize or sorghum for hay can be grown during summer. In the Black Sea Region after the winter barley harvest the silage maize yields 6,850 kg/ha dry matter (1). In the traditional cotton–cotton rotation the field is empty for a period of five to six months from November to April; so during that period of time short-lived annual forage vetch crops can be grown beneficially. In Adana Province of southern Turkey, the introduction of various leguminous forage species into rotations improved the subsequent cotton yield significantly (6).

In the Çukurova Basin, common vetch and field pea in a mixture with cereals (especially with triticale) can be grown as winter crops for hay production (Personal communication with Dr Celal Yücel). Similarly in the Aegean Region, where the cropping pattern is cotton–cotton or wheat–cotton, the winter crop can be pure vetch or vetch in a mixture with a companion cereal, which produces 5–7 tonnes/ha dry matter yield (Personal communication with Dr Huseyin Ozpinar).

Common vetch is the most widespread

Over the last three years, just as in the European Common market, the government has started to subsidise vetch crops to encourage their production. Common vetch is one of the most widely cultivated annual forage crops in Turkey. It can be grown almost everywhere in Turkey, but generally is sown in the coastal regions in autumn for hay, whereas in Central and Eastern Anatolia it is produced for seed and straw. Fırıncıoğlu *et al.* (9) reported that in the Central Anatolian region, three-year average seed and straw yields of common vetch were 770 kg/ha and 1,270 kg/ha, respectively. In the coastal areas or on irrigated lands, 5.0–7.5 t/ha of dried herbage can be produced (7, 11, 13). Table 1 shows the recent increase in the area sown to the major vetches from 1985 to 2004.

Cold tolerant and winter hardy vetches

Hungarian vetch, as a winter feed legume, is the most cold tolerant and winter hardy of the annual forage legumes and is highly recommended for fallow replacement as a pure stand or in a mixture with cereals, preferably barley for hay production. It was first introduced to Turkey in the early 1980s within the framework of the Corum-Çankırı Rural Development Project. It is an especially promising crop for the Central and Eastern Anatolian Regions. Over the last five years its cultivation area seems to have increased. Under dryland conditions, the average grain and dry matter yields were 700 kg/ha and 2500 kg/ha, respectively. In rainfed areas and in a mixture with barley, up to 3–4 t dried herbage /ha can be obtained.

Because of its cold and drought tolerance, Narbon bean can be grown successfully as a winter crop in the Central Highlands of Turkey. It is best grown for seed and straw yields in dry areas. It produces an impressive grain yield of 2.0–2.5 t/ha.

Bitter vetch has declined, but hairy vetches have potential

Table 1 shows that over the last 20 years, the area of bitter vetch has reduced dramatically to just a few thousand hectares. Formerly it was used to feed oxen, but mechanisation has diminished this use substantially. Herbage and seed yields varied from 1 to 2 t/ha and from 800 to 1,000 kg/ha, respectively (3, 4). Some lines of bitter vetch grown as winter crops produced up to 7,500 kg herbage/ha and 2,500 kg seed/ha (8, 19). Three-year average seed and straw yields of bitter vetch were 800 and 1,010 kg/ha respectively in Central Anatolia (9).

(Photo CRIFC, Ankara, Turkey)

Pre-basic seed production of Hungarian vetch (*V. pannonica* variety Tarmbeyazi-98) at CRIFC Research Station, near Ankara, Turkey.

Hairy vetch (*V. villosa* ssp. *villosa*) is a potentially important crop, which can be used as hay, pasture, green manure or cover crop. It is quite cold tolerant, and is planted in autumn and cut for hay in mid-June. It can be grown as a pure stand or in a mixture with barley. The pure stand produced 2,000–2,500 kg hay/ha, while the mixture with cereals produced 4,000–5000 kg hay/ha (2). The seed yield varies from 400 to 1,000 kg/ha (5, 16).

Hairy-pod vetch (*V. villosa* ssp. *dasycarpa*) yields slightly less, but it matures about two weeks earlier than hairy vetch. It is reasonably cold and drought tolerant. Because of its earliness, it can be incorporated easily into cropping systems.

Thus in Turkey, both the implementation by farmers and the ongoing research studies indicate clearly that the use of appropriate, intervening short-term, summer or winter legume rotations, can result in a substantial increase in overall crop production. ■

Table 1. The sown area (ha) and grain production (tonnes) of major vetches in Turkey in the last 20 years.

	Common vetch		Bitter vetch	
	Area sown (ha)	Production (tonnes)	Area sown (ha)	Production (tonnes)
1985	212,000	169,000	18,000	19,000
1990	259,000	175,000	11,000	11,000
1995	270,000	160,000	9,200	7,300
2000	225,300	134,000	3,550	3,600
2001	240,000	127,000	2,900	3,000
2002	234,227	129,124	2,850	3,000
2003	250,000	121,000	3,000	2,300
2004	320,000	130,000	3,200	2,500

Source: SSI (15)

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Contact:
For more detailed information on any of the Turkish references, please contact to Dr Huseyin K. Fırıncıoğlu, Head of Forage and Pasture Department, Central Research Institute for the Field Crops, P. O. Box: 226, Ulus/Ankara, Turkey. (huseyin@tr.net)

Progress in GL-TTP development

La GL-TTP en marche

by Catherine GOLSTEIN*

GL-TTP is an international Technology Transfer Platform created by the European Grain Legumes – Integrated Project (GLIP: http://www.eugrainlegumes.org) primarily to work on the integration, assessment and exploitation of the results of GLIP research. GLIP (54 partners) aims to boost the European production of grain legumes for animal feed and human consumption. The research programme of GLIP encompasses economic, environmental, agricultural and nutritional issues of crop legumes, as well as the production of genetic resources and genomic tools in model and crop legumes (for more information see the Special report articles in *Grain Legumes* **41** and **46**).

More broadly, the mission of GL-TTP is to facilitate the transfer of knowledge and cutting-edge technologies between research and industry to increase the production and quality of grain legumes worldwide. GL-TTP focuses initially on the interaction between research scientists and plant breeders in order to facilitate and expedite the genetic improvement of grain legume varieties to suit the needs expressed by grain legume producers, feed and food industries and end-users.

GL-TTP membership is growing

GL-TTP members constitute an international network across professional communities that support, contribute to, and benefit from, GL-TTP activities. GL-TTP stimulates cooperation between its member organisations to optimise the coordination and minimise the cost of technology transfer throughout the integrated chain of grain legume research development and use.

Seven months after its first General Assembly, seventy organisations have joined GL-TTP. The contractors of GLIP represent our largest contingent of members, but we also have non-European research organisations from Canada, Australia, and from the Consultative Group on International Agricultural Research (CGIAR). Private companies, mostly from the EU, but also from Canada, currently represent 15% of the members of GL-TTP. Breeding activities take place in both public and private organisations. In the next few years we will work towards a better representation of other continents to improve further the international coordination of legume improvement.

Activities reflect GL-TTP members' needs

To define relevant activities and services, we have surveyed the resources, activities, needs and constraints of our current members. At present the crops most represented in GL-TTP are pea and faba bean, and our members are interested primarily in a service of information and assistance with genetic resources and molecular marker development. As it grows, GL-TTP will adapt its activities to the crops, needs, resources and priorities of its new members.

To meet the current requirements, GL-TTP is developing six types of services across professional communities:

1. **information services** on research activities, breeders and producers' constraints, feed and food industry requirements, non-food industry status and grain legume markets;
2. **networking** to set up partnerships between research institutions and companies to facilitate the reduction to practice of specific innovations;
3. **consultation** to provide targeted advice on the application of new technologies and research advances in industry, especially in plant breeding;
4. **technical services**, including facilitated access to the genomic platforms developed in GLIP;
5. **training**, defined as individual training or collective workshops according to the needs and facilities of GL-TTP members,
6. **research and development**, notably for the characterisation of genetic resources and the development and validation of molecular markers for the implementation of marker-assisted selection in breeding programmes.

First GL-TTP workshop in Spring 2007

The first GL-TTP workshop on 'Molecular technologies for grain legume breeders' will enable expert scientists to provide an update on the molecular technologies available for grain legume breeders, including management of genetic diversity, genetic screening of exotic or mutant populations, and the development of molecular markers. The procedure for transfer and validation of molecular markers through GL-TTP will be presented for discussion and finalisation with GL-TTP members. In agreement with GL-TTP philosophy, unpublished molecular markers and unpublished *in vitro* technologies matching the interest of grain legume breeders will be disclosed at the workshop under a confidentiality agreement.

Analysis of requirements and state of the art

To feed the information service, initiate appropriate partnerships between scientists and breeders and define collective projects and training workshops, comprehensive questionnaire surveys have been developed and are currently being evaluated by GL-TTP members worldwide:

1) Breeding objectives survey

This survey aims to define breeding objectives more precisely, according to real production constraints and market preferences in specific regions targeted by plant breeders. It was initiated in GL-TTP in answer to our members' request for information on breeders and producers' needs, and to define rigorously the goal (breeding objectives) before the means (specific projects of technology transfer, characterisation of genetic resources, implementation of marker-assisted selection, etc.)

*GL-TTP, 38, rue de Berri, 75008, Paris, France. (c.golstein@prolea.com)

The rationale of the survey is to identify the local constraints of production and end-use, assess the suitability of breeders' material for each locally defined context, determine prioritised breeding objectives, and evaluate breeders' progress and bottlenecks in meeting their specific breeding objectives.

Throughout the survey, breeders are given the opportunity to ask for information on the constraints and requirements of their target zones of production and end-use, for support on the evaluation of their material for specific traits and conditions, and for assistance in identifying more adapted genetic resources.

These data will provide information on agro-ecological zones, markets, and corresponding breeding objectives for different legume species, which may facilitate the identification of regions with similar constraints for prospecting and exchanging genetic resources, for testing the performance of breeders' material, or for selling adapted varieties. In the future, the identified breeding objectives will be targeted with the most relevant knowledge and tools (such as molecular markers) identified in international research activities.

2) Genetic resources surveys

Considering the importance of enlarging the genetic base of modern varieties of grain legumes, one of the goals of GL-TTP is to facilitate the access and exploitation of genetic resources for their use in breeding programmes.

The first of two questionnaire surveys aims to assess breeders' awareness of the level of genetic diversity used effectively in their breeding programmes, to evaluate their current use of wild germplasm and germplasm banks, and to identify bottlenecks in the exploitation of wild germplasm. The second survey concerns the management of information on genetic resources. It will provide information on the format and type of data kept by breeders and used in their databases.

Based on the analysis of the results of these surveys, and in consultation with plant breeders, experts in genetic diversity, managers of germplasm banks and international coordinators of genetic resource management, GL-TTP will define collective projects or training workshops to evaluate the genetic diversity used effectively in grain legume breeding programmes across the world, propose exchanges of genetic resources between programmes based on their overall genetic distance, facilitate access to germplasm banks and the exploitation of wild germplasm, and suggest improvements to local databases for better interaction with germplasm bank databases and easier breeding workflow.

3) Molecular breeding technologies survey

This questionnaire survey, in preparation, is to evaluate the use of molecular technologies in grain legume breeding throughout the world and to identify the specific needs of GL-TTP breeders for training in new technologies.

Review of grain legume research and plant biotechnology

Activities in grain legume research and plant biotechnology are regularly reviewed and monitored through conferences and meetings, visits to research institutes and reviews of scientific publications, in order to assess and monitor the state of the art, create and maintain networks of experts, identify exploitable research and technology advances, and set up relevant partnerships between scientists and breeders.

To address the particular need for assistance in marker development, GL-TTP is reviewing the status of molecular markers likely to interest its members, and a procedure for their validation and transfer is currently being established. GL-TTP aims to facilitate the validation of existing molecular markers for GL-TTP breeders, or integrate the development and validation of new molecular markers for the benefit of both research scientists and plant breeders. ■

For more information, please visit the GL-TTP website at http://www.grainlegumes.com/gl-ttp/, or contact the GL-TTP director (f.muel@prolea.com) or the GL-TTP scientific manager (c.golstein@prolea.com).

Insert

Lucrative market for field pea sprouts in Western Australia

Les germes de pois : un débouché lucratif en Australie occidentale

Pea producers in Western Australia (WA) could increase their returns by supplying field peas to the lucrative sprouting market, if their grain meets market specifications. At A$1300 per tonne[1], field pea sprouts are a high value product with a wide range of uses, from salads and sandwiches, to stir-frys and soups. Currently WA produces 80,000 ha of field peas and that is estimated to increase to 150,000 ha by 2007.

In an honours project supported by CLIMA, University of Western Australia (UWA) student, Caroline Fowler researched the sprouting process in field peas, an important food, with 70% of production used for human consumption, mainly in the form of split peas, and the balance consumed by livestock.

To obtain sprouts, field pea seed from growers is soaked and germinated to develop the shoot in the dark. Then the sprouts are exposed to light to develop the green colour, a process that requires viable and uniform seed. In the project imbibition and germination were studied in three field pea varieties, Dundale, Dunwa and Helena were grown in WA at Mullewa, Merredin and Scaddan.

The major concern for sprout producers is the seeds that are non-viable or are slow to absorb water and germinate. While hard-seededness is a major problem for sprout producers, worth noting is that some field pea varieties grown in WA, with sprouting potential, may differ in their capacity to absorb water and subsequently germinate. Up to 15% of cleaned seed from growers does not germinate after soaking. The study suggests that careful variety selection and favourable growing sites should improve germination for sprout producers. Seed water content could also be a suitable selection criterion. Lower initial seed water content correlated with reduced germination within varieties across the different sites, which might have been the reason for a greater percentage of hard seeds in Dundale from the Merredin site.

Currently, sprout producers choose between the Dunn-type cultivars, Dunwa and Dundale, and selection is based on seed availability. The new variety, Kaspa, is not favoured by sprouters because of its semi-leafless character. Dunwa is popular for sprouting because sprouters believe its large seed size is related to greater yields, but Dundale had the lowest capacity to germinate and, of the three varieties tested, Helena had the best.

Source: CLIMA (www.clima.uwa.edu.au)

Targeting the high quality faba bean market

Accompagner une filière féverole de qualité

by Bernard GAILLARD*, J. COURTY** and W. PATSOURIS**

As part of the Grain Legumes Development Programme 2001–2005, set up by UNIP and the ARVALIS Technical Institute and financed by the National Office of Grain Crops, different initiatives are being taken to support production and utilisation in the grain legume sectors.

The aim of one of these initiatives, which began in 2004 and will be evaluated in the winter of 2006–2007, is to test the feasibility of a 'new' grain legume production and marketing 'channel' as a pilot experience and for use as an example to other cooperatives or private companies.

The Creully Cooperative in Normandy aims to produce high quality faba beans for exportation to the Egyptian food market. As this is a high-risk market, and highly competitive with Australia and Great Britain, the feed market can be considered as another outlet for the crop.

The work of UNIP and the ARVALIS regional department was to offer technical support to the cooperative at three levels: the managers, technical advisers and farmers.

The managers were advised how to organise production and marketing, based on the activities of another cooperative with several years of experience in the faba bean sector.

Technicians were given training sessions, indoors and in the field, especially on cropping practices from sowing to harvest.

Farmers' awareness and abilities were assessed in meetings in the fields and through the distribution of 'Faba Bean Notebooks'. One of the main problems on which advice was given over a two-year period was weevil damage since it is the damage caused by this insect that excludes seeds from the food market.

Lastly, a TV report was recorded and televised on the Normandy Channel in May 2005, and this included an interview with the President of the Creully Cooperative, Yves Julien. ■

(Photo ARVALIS-UNIP, France)

To reach potential yield, faba bean plant density has to be optimum, about 30–35 plants/m² for spring sowing and 20–25 plants/m² for autumn sowing.

(Photo ARVALIS-UNIP, France)

The Egyptian market demands visual seed quality: colour, shape and lack of spotted or perforated seeds.

The Creully Cooperative in the centre of a rich plain in lower Normandy

The Creully Cooperative includes 1,200 farmers in the north-west region of Calvados. It harvests 200,000 t of the main grain crops including 12,000 t peas and 3,000 t faba beans. The plain of Caen, which is the main production area of the cooperative, is based on a deep rich silty soil, above a fissured limestone substrate.

Thanks to fertile soils and a moderate climate (annual rainfall 800 mm), average crop yields are good, about 9.5 t/ha of winter wheat and 5 t/ha of spring faba bean.

The plain of Caen is a traditional pea producing area; at the end of the 1980s, pea was the most important first crop in the rotation but it decreased significantly in favour of sugar beet, linseed and potatoes. There were two reasons for this change: the first was the low yields either because of root diseases caused by the frequency of pea in the rotation, or unfavourable climatic conditions in the springs of the last two years. The second reason for the decreasing pea area was the drop in margins, due to selling prices and the new CAP.

For this reason farmers were looking for new crops to head the rotation. By deciding to grow faba beans, farmers had several aims:

– to take advantage of new profitable markets, either the food export market or the local protein feed market,

– to have a good previous crop for healthy wheat, without mycotoxins,

– to diversify their production system.

In two years the faba bean area increased from 200 to 700 ha. In 2005, yields reached 5–6 t/ha for spring faba bean and 4–5 t/ha for winter faba bean. The price paid to farmers was about €120/t.

*ARVALIS–UNIP Station La Jaillière, La Chapelle-St-Sauveur, France. (b.gaillard@arvalisinstitutduvegetal.fr)

**Cooperative of Creully, Normandy, France. (jcourty@coopcreully.com; (wpatsouris@coopcreully.com)

The potential of yellow lupin as a protein source in southern Chile

Le potentiel du lupin jaune comme source de protéine au Chili

by Enrique PEÑALOZA*, Mauricio OSORIO*, Haroldo SALVO-G* and Peter D. S. CALIGARI**

The increasing interest in plant proteins from the aquaculture industry is providing a promising future for lupin development in Chile. Presently, plant protein for use in such industries comes mainly from imported soyabean meal supplemented by local production of white lupin (*Lupinus albus*) and narrow-leaved lupin (*L. angustifolius*). Both lupin species share about 28,000 ha, 70% of which corresponds to sweet forms. Low seed alkaloids (<0.05%) and higher seed protein (>38%) are the main requirement for plant protein to satisfy the industry. Though total alkaloids are usually lower than 0.05%, the whole grain has to be dehulled to concentrate the protein. By processing this way, the protein in the kernel is increased up to 43% in *L. albus* and 39% in *L. angustifolius.* However, such protein content is still not enough to compete successfully with soyabean meal. Only its GMO-free condition gives lupin a competitive advantage as a feed ingredient for the aquaculture sector. Therefore, lupins with a seed protein content higher than *L. albus* and *L. angustifolius* would be needed to develop sustainable lupin production in Chile. This implies that *L. mutabilis* and/or yellow lupin (*L. luteus*) would be species to be considered to reach such a goal.

Although the first sweet *L. mutabilis* cultivar was developed in Chile in the early 1970s (7), seed yields were not sufficient to make it a commercial crop. The same situation was observed for sweet cultivars of yellow lupin introduced from Europe in the 1960s, with average seed yields lower than 2000 kg/ha (5). The inadequate agronomic performance of both high-protein lupin species would probably explain why breeding *L. mutabilis* and *L. luteus* was not pursued further with any vigour, as it was with *L. albus*. Breeding *L. albus* is currently carried out in Chile by a private company, which has been releasing cultivars of this species since the early 1960s.

The recent findings from Australian researchers showing the potential of yellow lupin in the aquaculture industry (3) have led to the reconsideration of this species as a potential protein source. Having this in mind, a range of accessions of yellow lupin was introduced recently from the germplasm collection held in Poland, comprising genotypes previously not evaluated in Chile. Preliminary results show that yellow lupin genotypes performed much better than expected, which has renewed the prospects for breeding and developing this species as a commercial crop in Chile.

Promising attributes

Yellow lupin accessions were first multiplied in the field. Due to significant phenotypic variability observed within some of the genotypes, single plant selection was carried out. Seeds from the highest producing single plant of each accession were established in a preliminary yield trial, in the highly productive and humid environment of southern Chile, along with *L. angustifolius* cv. Wonga for comparison. Seed yields averaged 2800 kg/ha but ranged from 900 to 4200 kg/ha (Figure 1a). Although these might be considered as some of the highest seed yields reported for yellow lupin in the world, they must be treated with caution as they come from small, 5-m^2 plots. Seed yield of *L. angustifolius* was below the reported average mainly as a consequence of severe Fusarium infection. Fusarium was not detected in many yellow lupin genotypes indicating that, potentially, they posses resistance to Fusarium, at least the local races, probably derived from the early work in Germany (1).

Seed samples from each accession were dehulled manually to estimate variability of the seed coat proportion as well as to characterise genotypes according to their industrial seed yield. The average proportion of seed coat was 24.8% but ranged from 21.7% to 29.3% (Figure 1b). Dehulled samples were evaluated for protein content (DW basis) by the macro Kjeldal method. Dehulled seed protein averaged 55.7% which is much higher than soyabean meal or dehulled *L. albus*. Seed protein in dehulled grains varied from 48% to 61% (Figure 1c). Based on Kurlovich's results (4), this higher protein content is probably the consequence of the humid environments that characterise southern Chile. In these samples, total alkaloids, as measured by the volumetric methods of von Baer (8) were from 0.01% to 0.86% (Figure 1d). Fifty per cent of the accessions were below the 0.05% alkaloid level, which is the maximum acceptable to be considered as sweet lupin under national regulations.

Based on these preliminary results, the variability observed between yellow lupin accessions considerably exceeds not only the parameters of quality that characterise *L. albus* and *L. angustifolius* but also those required by the aquaculture industry. Seed yield figures suggest that it could be possible to breed for a commercial seed yield higher than 3500 kg/ha, with a kernel protein content of 55%. This means a protein yield of about 1500 kg/ha, which is within the economic threshold for lupin production at the farm level.

* Unidad de Biotecnología, INIA Carillanca, Temuco, Chile. (epenaloz@inia.cl)

** Instituto de Biología Vegetal y Biotecnología, Universidad de Talca, Talca, Chile. (pcaligari@utalca.cl)

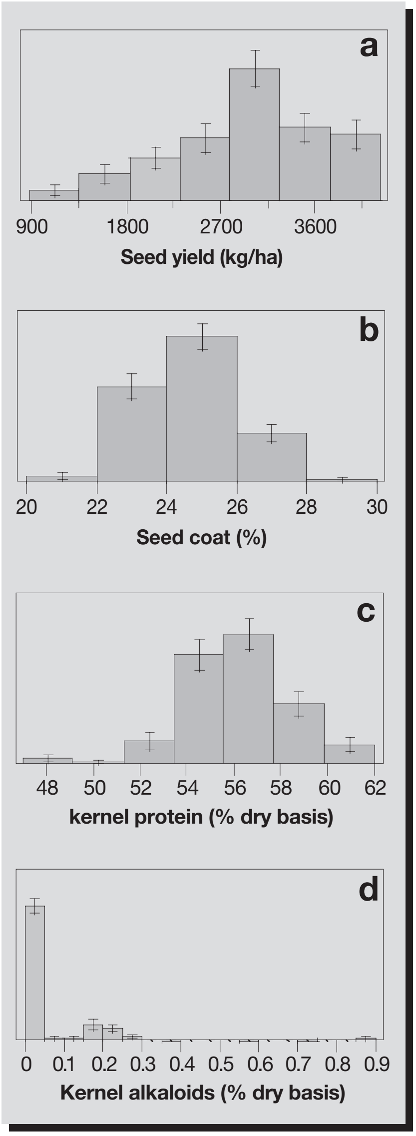

Figure 1. Frequency distribution of (a) seed yield, (b) seed coat, (c) kernel protein and (d) kernel alkaloids of 110 yellow lupin (*Lupinus luteus*) accessions evaluated in southern Chile.

Competitive in specific soils

Soils from southern Chile are characterised by their acidic nature, which makes phosphate deficiency and aluminium toxicity the main constraints for crop production. Tolerance to phytotoxic aluminium (6), as well as low response to phosphate (2) makes yellow lupin a species suitable for such environments. Although neither nitrogen nor inoculum were used, accessions nodulated profusely, indicating that the species would be suitable as a low input crop for small-holder farming.

Although Anthracnose is the main disease of lupin in southern Chile, its incidence was not significant through the two years of evaluations in soils on which lupin had not been established before. Nonetheless, Anthracnose is expected to be a production constraint to be taken into serious consideration in developing this species as a commercial crop.

One point that has to be stressed is the well-known lower seed yield performance of yellow lupin compared with *L. albus* and *L. angustifolius*. If this trend is proved to be true in our lupin environments, then care is going to be needed in choosing the right soils to make yellow lupin competitive with the other lupin species. Such environments would be soils on which Fusarium and/or Pleiochaeta incidence does not allow *L. angustifolius* to grow without high chemical inputs, those with phytotoxic aluminium levels higher than 25%, or those on which a spring sowing is not possible for *L. albus* to be established.

Promising outlook

The increasing cost of fish meal coupled with an expected reduction in the supply of fish-derived products is at present considered to be a major problem facing the aquaculture industry. This scenario provides an opportunity to increase the area of cultivation of lupins as the main source of plant protein. Based on expected demand, a potential for more than 100,000 ha of lupins has been estimated. The advantages of yellow lupin over soyabeans suggest that this species would complement fish meal in the aquaculture industry and would be used as an ideal substitute for soyabean meal in other feed industries.

(Photo UNIP, Paris, France)

Yellow lupin (*Lupinus luteus*) flower.

The development of yellow lupin as a commercial crop will allow industrial processing to go further than simply dehulling. Therefore, production of protein concentrates and isolates is at present being considered as an avenue to incorporate added value to the lupin grain. This kind of innovation is expected to create new niche markets that will make lupin production more sustainable.

The availability of yellow lupin from the range of world germplasm has allowed us to initiate a breeding programme in Chile, which is presently being concentrated on developing varieties with improved nutritional attributes such as protein quality and content, and reduced phytate, seed coat and α-galactosides in seeds. Such attributes will be combined into a well-adapted genetic background, with the help of the molecular mapping of nutritional and agronomic traits to develop marker-assisted breeding. ■

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AEP

12, avenue George V, 75008 Paris, France

Tel: +33 1 40 69 49 09 · Fax: +33 1 47 23 58 72

http://www.grainlegumes.com · Email: aep@prolea.com

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COVER PHOTO:
2005 Western Australian field trial of the white-seeded, *Vicia sativa* cultivar Love 2.
(Photo Mark Seymour and Pam Burgess, Department of Agriculture and Food, Western Australia, Perth)

PHOTO DE COUVERTURE :
Expérimentation au champ de la variété à graines blanches 'Love 2' de Vicia sativa, *à l'ouest de l'Australie en 2005*
(Photo : Mark Seymour et Pam Burgess, Department of Agriculture and Food Western Australia, Perth)

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The AEP is an associative network of persons with interests in grain legume research (peas, faba beans, lupins, chickpeas, lentils, dry beans, etc.) to favour the exchange of information and multidisciplinary collaborations (Conferences, publications, workshops, joint projects). It aims both to strengthen the research works and to enhance the application of research into the integrated chain of grain legumes.

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Union Nationale Interprofessionnelle des plantes riches en Protéines

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Tel: +33 1 40 69 49 14 • Fax: +33 1 47 23 58 72
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The UNIP is the representative organisation of all the French professional branches of the economic integrated chain of grain legumes. It provides information about pulse production, utilisation, and the market and it coordinates research works related to grain legumes in France, especially peas, faba beans and lupins for animal feeding.

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The PGRO provides technical support for producers and users of all types of peas and beans. Advice is based on data from trials sited from Scotland to the South West of England and passed to growers and processors through technical bulletins and articles in the farming press.

APPO

Belgian Association for Oilseeds and Protein Crops

Association pour la promotion des protéagineux et des oléagineux

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Tel: +32 81 62 21 37 • Fax: +32 81 62 24 07 • Email: appo@fsagx.ac.be

The APPO is the representative organisation of Belgian growers of oilseeds and protein crops, especially rapeseed, peas and faba beans. The main tasks are experimentation, giving advice to producers, providing technical and economic information through meetings and mailings and encouraging non-food uses of vegetable oil.

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3 rue Joseph et Marie Hackin – 75116 PARIS
Tel: 33 (0)1 44 31 10 00 • Fax: 33 (0)1 44 31 10 10
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Run and financed by French farmers, Arvalis-Institut du végétal carries out and disseminates applied research on the production, storage and utilisation of cereals, grain legumes, potatoes, and forage.

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Andreas Hermes Haus – Godesberger Allee 142-148 – 53175 Bonn – Germany
Tel: +49 22 88 19 82 27 • Fax: +49 22 88 19 82 03
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UFOP is the representative organisation for German producers of oil and protein crops. It encourages professional communication, supports the dissemination of technical information on these crops and also supports research programmes to improve their production and use.

CRA-W

Animal Production and Nutrition Department
Rue de Liroux 8 – 5030 Gembloux (Belgique)
Tel: +32 81 62 67 70 • Fax: +32 81 61 58 68
Email: prodanim@cra.wallonie.be • http://cra.wallonie.be

A broad research topic of the Animal Production and Nutrition Department deals with the utilisation of lupin and pea seeds in animal feeding (ruminant, monogastric and poultry) in terms of nutritional value, environmental benefits, protein utilisation and economic aspects. The research is also concerned with the development of legume silages, seed treatments prior to feeding and seed processing for non-food uses.

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1212–220 Portage Avenue – Winnipeg
Manitoba – Canada R3C 0A5
Tel: +306 651 0858 • Fax: +306 668 5557
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Pulse Canada is a national industry association. This organisation represents provincial pulse grower groups from Alberta, Saskatchewan, Manitoba, Ontario and the pulse trade from across Canada who are members of the Canadian Special Crops Association. Pulse crops include peas, lentils, beans and chickpeas.

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