# Cool Season Food Legumes Crop Germplasm Committee Report

# May 1998

# TABLE OF CONTENTS

# I. Introduction

Cool season food legumes, such as lentil (*Lens culinaris*), chickpea (*Cicer arietinum*), faba bean (*Vicia faba*) are commercially important crops in the western United States. The most important of this group is lentil which is grown on an average of 150,000 acres annually in the Washington, Idaho and Oregon area popularly known as the Palouse region. Chickpea is grown to a lesser extent when compared to lentil but is grown over a wider area. About 6,000 to 8,000 acres are currently grown in California, 15,000 to 20,000 acres in the Palouse region, and various small acreages in the states of Montana, Colorado, and North Dakota and South Dakota. Chickpea production in the Palouse region has increased rapidly since 1993 and now stands at 20,000 acreas annually. Faba bean is grown in Oregon, Washington, California, Wyoming and Montana where the corp is mainly produced for forage.

Other potential cool season food legumes that should be investigated and studied include *Lathyrus* species, primarily *L. sativus*, and *Trigonella* species, primarily *T. foenum-graecum*. These food legumes have potential in the arid west where they can be grown in rotation with cereals. As a group, these crops can tolerate cool, dry conditions and low fertility. They often are grown in marginal areas that are unsuited to other crops.

Of this group of crops, the most important to the U.S. economy is lentil. Of the total production of over 200 million pounds annually, about 75% is exported. Europe, North Africa and Latin America are primary markets. Most of the chickpea, faba bean and lupin crops are used domestically. The production of chickpea in the Palouse region and California directly benefits the U.S. economy by reducing imports from Mexico and providing an export commodity. Lupin is reemerging as a cover crop for cotton in the Southeast (AL, GA, SC); currently there are approximately 2000 acres planted each year; the acreage is expected to increase dramatically within the next five years.

Most of the acreage of lentil in the U.S. is planted to 'Brewer', with limited production of 'Chilean', 'Laird', 'Eston', 'Redchief', 'Emerald', 'Palouse', and 'Crimson'. Production of the so-called Spanish Brown type or 'Pardina' has greatly expanded over the past 5 years and currently over 50,000 acres of that type are grown in the region. The commercial acreage of chickpea in the U.S. is in the process of switching over to ascochyta resistant varieties developed by USDA-ARS at Pullman, WA. Currently, nearly 95% of the production in the Palouse region is from blight resistant cultivars; however, there are still problems with blight in California and there is an effort to develop and introduce resistant cultivars there.

Faba bean production is extremely limited and diseases have not been a problem if Ascochyta-free seed is used. White lupin is also grown on a limited acreage with some problems with Fusarium wilt, Phytophthora root rot, a bacterial disease, and anthracnose.

Although an ancient crop of the mediterranean region, lupin (*Lupinus* spp.) is the most recently developed crop of this group of food legumes and is grown primarily in the Southeast and the Atlantic Provinces of Canada. Lupin was an important cover crop in the southeastern United States from the late 1930s until the early 1950s. Currently, lupin is primarily grown as a high protein feed for animals on very limited acreage. There is, however, a concerted effort in the Southeast to revive lupin, particularly white lupin (L. *albus* ) as a cover, silage and grain crop. Cover crop effect on yield potential of ultra-narrow row cotton (*Gossypium hirsutum* L. ) in the southeastern US generally follows the order legume>black oat>winter fallow and was related to biomass production of the winter cover, as well as to type of cover (Reeves et al., 1998). No-tillage into a white lupin cover crop that produced 6800 lb dry matter/A resulted in the greatest lint yield (1390 lb/A).

## II. Present Germplasm Activities

***Cicer***

ICARDA and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India have extensive collections of chickpea. The initial material used to form these collections was made available by the former USDA-ARS Regional Pulse Improvement Project centered in Iran and India in the late 1960s. During the course of the project, 4,177 accessions of cultivated types were systematically assembled. Most of this collection is also maintained by the USDA-ARS Regional Plant Introduction Station (RPIS) at Pullman, Washington. The RPIS collection currently numbers 3,795 accessions representing both cultivated and wild forms from about 20 countries. Several areas of the world are currently under-represented in these collections. Prime examples are the countries of eastern Europe, such as Iraq, Bulgaria, Romania, Yugoslavia, Italy, Uzbekistan, Turkmenistan and Afghanistan. Wild species from southeastern Turkey and parts of Iraq are particularly lacking in the collections, but represent potentially useful germplasm for cultivar improvement. These areas should provide additional sources of Ascochyta blight resistance. Collection in those areas should be very beneficial.

***Lens***

The International Centers maintain the largest and most extensive germplasm collections of several food legumes. The International Center for Agricultural Research in the Dry Areas (ICARDA) located in Syria has a lentil collection of over 5,900 accessions. The ICARDA collection includes the national collections from India, Iran, Turkey, Ethiopia and the U.S. In addition, the ICARDA collection includes many of the wild species from their mandate areas and the extensive collection of wild species of *Lens* made by Ladizinsky. The U.S. collection contains over 4,500 accessions of cultivated and wild species that were collected from over 40 different countries. Several areas of the world where lentil is grown to a minor extent are not well represented. Prime examples of under-represented areas are Morocco, Algeria and Afghanistan, Eastern Europe, Ethiopia, Iraq, Uzbekistan and Turkmenistan.

***Core Collections for Cicer and Lens***

Core collections of germplasm were developed for the chickpea collection in 1988, and for the lentil collection in 1989. The chickpea core consists of 505 accessions which is 11% of the current collection size. There are 278 lentil accessions in the core, which is 10% of the total current collection. Both cores were selected by a modified logarithmic method, which placed primary emphasis on the geographic country of origin. After grouping by country, secondary selection was performed on the basis of seed and flower characteristics. Known unique phenotypes were selected for inclusion as well. The modified logarithmic nature of the selection was such that for countries represented by fewer than ten accessions, all accessions were included in the core. From there it was scaled down so that for countries with 10-20 accessions, ten were selected. For countries that had 20-30 accessions, half of the accessions were selected for inclusion. Similar scaling was used to the point that for countries with more than 100 accessions, only 10% were selected for the core, with consideration of representation for seed and flower characteristics. When each of these core collections was selected, each of the total collections was considerably smaller, so the initial relative size of each core was about 15%, instead of the 10% or 11% that it is today. Both of these cores have been utilized quite heavily since they were developed.

***Lathyrus* and *Trigonella***

The *Lathyrus* and *Trigonella* collections maintained at the RPIS in Pullman comprise 651 and 245 accessions, respectively (Table 1). Collections in other countries are quite small; however, these crops are important in India, Pakistan, the Middle East and North Africa. They are not produced to any extent in the U.S. However, near-zero neurotoxin lines of grasspea (*Lathyrus sativus* ) have been developed in Bangladesh and also in India and Canada. With this development the crop will likely become more widely grown in developed and developing countries in the forseeable future.

***Lupinus***

Twelve major International Centers maintain substantial number of accessions lupin (Table 1). The largest collections are maintained in Australia, France, Germany, and the UK. The Regional Plant Introduction Station at Pullman currently maintains some 1060 accessions from over 30 countries (Table 2). Cultivated lupin species (*L. albus*, *L. luteus* and *L. angustifolius* ) have their origin in the Mediterranean area, but another crop species (*L. mutabilis* ) has its origin in the Andean highlands of South America. North America is home to more than 150 native species of non-food lupin. Because of the high quinolizidine alkaloid content of these species they are toxic to livestock. Another species was found to be one of the pioneers in the revegetation of Mount St. Helens after the eruption. Native lupin, both domestic and abroad represent a secondary genepool for the improvement of food and feed lupin species. More collections need to be made in this area.

**Table 1.** Lupin accession held by various countries.

| Country | No. Accession | Species | Information provided by |
|---|---|---|---|
| Australia | 1000 | | |
| France | 1600 | | C. Hyughe, INRA, Lusignan, France |
| | 1200 | albus | |
| | 300 | mutabilis | |
| | 100 | other (10 species) | |
| Bulgaria | 221 | | |
| Germany | 2800 | | FROM:<br>Genetic Resources<br>Section Meeting of the EUCARPIA,<br>Budapest, 1996<br>PROVIDED BY:<br>Wojciech Swiecicki, Poznan, Poland<br>(Manager European Lupinus Collections Database) |
| Hungary | 255 | | |
| Israel | 186 | | |
| Poland | 1000 | | |
| Portugal | 1000 | | |
| Spain | 1621 | | |
| UK | 1200 | | |
| USA | 1060 | see Table 2 | C. Simon, Curator, W-6 Large-seeded Legumes |

Replicated field trials containing 74 Lupinus albus accessions (representing 27 countries) was conducted in central Maine in 1997 to evaluate white lupin for its potential for grain production under northern latitude conditions (Merrick 1997). The focus of the 1997 trial was to screen for resistance to anthracnose, a fungal disease caused by *Colletoctrichum gloeosporides*. Experimental application of anthracnose in 1997 proved unnecessary, however, because a significant natural outbreak of the disease occurred. The first lesions were apparent in the field within weeks of plant emergence and by mid-July most rows exhibited diseased or dead plants with one to multiple lesions. Unfortunately the trial ended prematurely in late July due to severe stress caused by the simultaneous abundant infestation of *Empoasca fabae* , the potato leafhopper, which was present in extremely high numbers on the lupin plants as well as reported state-wide as seriously limiting yields for potato, dry bean, and other crops. Data from July sampling periods indicate that two Polish accessions--PI 468128 ('Kalina') and a landrace known as 'Byaly'--and an improved Ukrainian variety, cv. Vladimir, were the most promising white lupin accessions for potential anthracnose resistance. Each had almost no lesions present across all replicated plots. Vladimir has been one of the earliest maturing varieties evaluated in previous University of Maine trials and was rated as one of the least anthracnose-susceptible (none were highly resistant) cultivars in a multi-year trial of seven white lupin cultivars in Nova Scotia.

**Table 2.** Status of the US Cool Season Food Legume Collections (March 1998)

| Taxon | Crop | No. of PIs | No. of W6s | Total No. | Avail-ability (%) | Total in NSSL(%) |
|---|---|---|---|---|---|---|
| <u>*Cicer*</u> | | | | | | |
| *arietinum* | chickpea | 3998 | 432 | 4430 | 3987(99) | 3860(97) |
| *other* | 20 species | 127 | 12 | 139 | 105(83) | 33(26) |
| <u>*Lathyrus*</u> | | | | | | |
| *sativus* | grasspea | 227 | 15 | 242 | 222(98) | 166(73) |
| *other* | 32 species | 216 | 193 | 409 | 187(87) | 87(40) |
| <u>*Lens*</u> | | | | | | |
| *culinaris* | lentil | 2389 | 323 | 2722 | 2388(99) | 2385(99) |
| *other* | 4 species | 91 | 67 | 158 | 67(74) | 0 (0) |
| <u>*Lupinus*</u> | | | | | | |
| *albus* | white lupin | 158 | 159 | 317 | 124(78) | 53(34) |
| *angustifolius* | blue lupin | 152 | 30 | 182 | 96(63) | 68(45) |
| *mutabilis* | tarwi | 68 | 11 | 79 | 19(28) | 1 (1) |
| *luteus* | yellow lupin | 54 | 14 | 68 | 27(50) | 8(15) |
| *other* | 47 species | 313 | 101 | 414 | 187(60) | 75(24) |
| <u>*Trigonella*</u> | | | | | | |
| *foenum-graecum* | fenugreek | 156 | 18 | 174 | 152(97) | 155(99) |
| *other* | 22 species | 54 | 17 | 71 | 49(91) | 25(46) |
| <u>*Vicia*</u> | | | | | | |
| *sativa* | common vetch | 574 | 89 | 663 | 53493) | 496(86) |
| *faba* | broadbean | 403 | 142 | 545 | 392(97) | 316(78) |
| *ervilia* | bitter vetch | 117 | 26 | 143 | 91(78) | 16(14) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *villosa* | hairy vetch | 87 | 15 | 104 | 58(65) | 21(24) |
| *benghalensis* | purple vetch | 30 | 0 | 30 | 23(77) | 1 (3) |
| *pannonica* | hungarian v. | 16 | 2 | 19 | 6(38) | 0 (0) |
| *other* | 34 species | 166 | 308 | 474 | 74(45) | 7 (4) |

***Vicia***

An extensive collection of faba bean (*Vicia faba* ) is maintained at ICARDA. Also, collections for breeding purposes are held at Bari, Italy, and Braunsweig and Gatersleben, Germany. A large collection is held at St. Petersberg, USSR, but we have limited access. Germplasm of faba bean from China, India, Afghanistan, Iran and the Andes of South America is under-represented in these collections. Faba beans have been isolated in the Andes for over 300 years and many land races are present, with one or more in each valley. Some of the Andean land races are resistant to chocolate spot, caused by *Botrytis fabae*. The U.S. collection held in Pullman contains only 353 accessions. The center of origin of faba bean or its wild progenitor is unknown, but the largest producer of the crop is China where approximately 60% of the world's production is grown.

Discussions began in late 1992, which considered the consolidation of the entire *Vicia* collection at the Western Regional Plant Introduction Station in Pullman, WA. At that time, of the 1585 *Vicia* accessions, 379 were assigned to the South Atlantic Area Regional Plant Introduction Station in Griffin, Georgia, with the other 1206 accessions already in Pullman. While Griffin had fewer accessions than Pullman, they had a larger number of species. In a memorandum dated March 19, 1993 from Dr. Gil Lovell, former Coordinator in Griffin, to Dr. Ray Clark, former Coordinator in Pullman, merits of moving the 379 Griffin accessions to Pullman were delineated. In this memo, Dr. Lovell stated: "In the 13 years I have been here we have not grown vetch for seed increase for two reasons: (1) because of limited plot land our summer season plantings interferred with early fall plantings of vetch and our hot May and June temperatures reduced flower set and pod maturity, and (2) there was little documented information of the pollination modes (self or cross-pollination) of the various species we hold." The memo went on to discuss a project funded to Dr. Jorge Mosjidis researching *Vicia* pollination systems, which is discussed elsewhere in this report. On April 12, 1993, Dr. Clark agreed to the transfer in a memo to Dr.Lovell, and the 379 Griffin accessions arrived in Pullman shortly thereafter.

Information on the breeding system of plants is crucial for maintenance of accessions in germplasm banks (Zhang Mosjidis, 1995). Controlled pollination experiments were conducted in the field to determine the breeding systems of several *Vicia* species. *Vicia articulata* Hornem., *V. benghalensis* L., *V. ervilia* (L.) Willd., *V. lutea* L., and *V. sativa* L. were automatic self-fertilizing species. *Vicia pannonica* Crantz was nonautomatic self-fertilizing. *Vicia villosa* Roth ssp. *villosa* and *V. villosa* Roth ssp. varia (Host) Corbiere were cross-fertilizing. Therefore, regeneration of the accessions of the latter two species requires the use of procedures that provide isolation from foreign pollen.

Maintenance and use of germplasm collections of *Vicia* species is difficult because of limited information on their mating systems (Zhang Mosjidis, 1998). Polymorphism of seven enzyme systems in 31 accessions of 12 Vicia species were measured using isoelectric focusing with the purpose of inferring their mating system. Polymorphism indices were calculated using isozyme bands to compare variability within and among accessions and between species. All enzymes studied had polymorphic banding patterns. Twenty eight accessions were variable for at least one of the seven enzymes, whereas three otheraccessions were uniform for all seven enzymes. Within-accession variationwas larger than that among accessions in *V. villosa* and *V. villosa* ssp.*varia*, whereas within-accession variation was smaller than that among accessions of *V. articulata*, *V. benghalensis*, *V. cracca*, *V. ervilia*, *V.lutea*, *V. narbonensis*, *V. pannonica*,. *V peregrina*, and *V. sativa*. The results agreed with field tests which demonstrated that *V. villosa* and *V.villosa* ssp. *varia* are predominantly cross-fertilizing species, whereas the other species are mainly self- fertilizing. The use of isozyme bands to determine mating system proved to be accurate. In addition, this method is convenient because it utilizes a small seed sample and is inexpensive and easy to perform.

## III. Status of Crop Vulnerability

***Cicer***

Chickpea is vulnerable to several diseases that have, in certain instances, caused severe crop losses. Foremost of these diseases is Ascochyta blight caused by *Ascochyta rabiei*. This disease is seedborne and is prevalent in the Palouse region, California and other areas of North America where the crop is grown. Ascochyta blight is prevalent in most chickpea-growing regions of the world. Work on this disease is centered on development of resistant cultivars. Resistant breeding material is available from the ICARDA and ICRISAT programs. However, new and more virulent pathotypes or races of the fungus have developed which have overcomed the available resistance. Three pathotypes of the fungus have been identified in the Middle East that are currently capable of causing disease on previously considered resistant germplasm. Fortunately, the resistance deployed in the U.S. has remained stable and it seems that in the near future the disease can be controlled satidfactorily. Fusarium wilt of chickpea is caused by *Fusarium oxysporum* f. sp. *ciceri*, a soilborne disease, and consists of several races. This fungus is seedborne. Resistance to the disease is conferred by at least two recessive genes. Host plant resistance offers the least costly, most effective and most environmentally acceptable means of control. This disease is prevalent in California, but has not been reported in the Palouse region. Other diseases, such as Botrytis grey mold, are important elsewhere, but not in the U.S. Insect pests of chickpea are not important in the U.S. except for the aphids which transmit viruses. In other regions of the world, *Helicoverpa* (*Heliothis*) *armigera* is by far the most damaging pest of chickpea, while leaf miner can also cause problems.

***Lens***

The root rot/wilt complex is the most important disease of lentil worldwide, but is generally not a serious problem in the U.S. Ascochyta blight of lentils, incited by *Ascochyta fabae* f. sp. *lentis* can be economically important in areas that receive heavy summer rainfall. These conditions generally do not occur in the Palouse region. Anthracnose caused by *Colletotrichum truncatum*, has recently become an important disease in the more humid part of the lentil growing area in western Canada and in the expanding production areas of North Dakota. Rust (*Uromyces viciae-fabae*) is a serious disease of lentil in South America, India, Pakistan, Morocco and Ethiopia, but it does not occur in the U.S. Utmost care must be exercised in the movement of seeds into the U.S. from rust-infested areas. Currently available commercial cultivars are susceptible to the disease. Several viruses naturally infect lentil in the Palouse area, including pea enation mosaic, pea streak, bean (pea) leaf roll and alfalfa mosaic. In the U.S., lentil is attacked by several aphid species which transmit viruses and sometimes cause direct damage. The most important insect pest of lentil in the U.S. is *Lygus* bug (*Lygus* spp.) which causes an anomaly locally known as "Chalky spot". Worldwide, insect pests of lentil include pod borers, aphids, weevils, bruchids and cutworms.

***Lupinus***

Diseases of crop lupins will become important as acreage increases because of the reservoir of inoculum available in the many and widely distributed species of wild lupin in the U.S. Anthracnose, caused by *Colletotrichum*, has recently become serious in many areas. Domestically, diseases caused by the *Fusarium* complex, *Colletotrichum*, and *Pleiochaeta* are most yield limiting. No important insect pests occur on lupin in the U.S., except for the seed corn maggot. *Lygus* bugs may also serve as a vector of a bacterial disease of lupin. Bud worm moths are destructive in some countries. Other pests include mites, fleas, aphids and thrips. Recently, however, a lupin fly (exact species still not determined) has become noticaeble in some lupin plantings (K. Flanders, 1998, personal communication).

***Vicia***

Worldwide, faba beans are affected by a number of diseases including chocolate spot (*Botrytis fabae*), rust (*Uromyces viciae-fabae*) and Ascochyta leaf spot (*Ascochyta fabae*). Numerous viruses affect the crop, including pea enation mosaic, bean leaf roll, pea streak, bean yellow mosaic and alfalfa mosaic. No important insect pests occur on faba bean in the U.S. other than aphids which serve as vectors for a number of virus diseases. Worldwide, important insect pests include leaf weevils, bruchids and aphids.

## IV. <u>Germplasm Needs</u>

***Collection***

Even though the collections of lentil and chickpea held by the USDA RPIS in Pullman are large, a number of identifiable gaps exist. These gaps include Russia, the Ukraine, eastern Turkey, Uzbekistan, Turkmenistan, Afghanistan, Iraq, Ethiopia and Iran. In particular, collection is needed in southeastern Turkey and Iraq where these crops are widely grown and where the wild relatives of these crops are also found. Accessions from India, Iran , China and the Andes of South America are not well represented in the U.S. collection of faba bean, even though these are the world's most important production areas. The U.S. lupin collection is small. However, additional collection of lupin is not a high priority item in view of the numerous collections of lupins held in other countries. What is important, however, is to develop formal agreements which will allow the timely exchange of material.

Exploration and collections of cultivated and wild species of lentil and chickpea should be planned for areas that are not now well represented in the U.S. collection. For example, chickpea should be collected in Russia and the Ukraine because those countries are a source of material with resistance to Ascochyta blight. Neighbouring countries might also be explored for cultivated forms and related wild species. Lentil also should be collected in areas of Turkey, Iran, Iraq and Afghanistan. These areas are not well represented in our collection, but have wide genetic variation among cultivated forms. Also, a number of wild relatives of lentil occur there.

With regard to faba bean, lupin, *Lathyrus* and *Trigonella*, species can be collected concurrently with the collection of lentil and chickpea. Recent plant explorations for food legumes have been made in countries of the former USSR, particularly Uzbekistan, and China; however, variation collected there has been minimal compared to collections that have been made closer to the centers of origin. We have identified a good contact in Ethiopia for possible future collection there. The committee needs someone willing to propose and carry out a collection mission there.

***Evaluation***

Collections of these crops should be evaluated for several factors currently restricting production. These include Ascochyta blight of chickpea, pea enation mosaic virus of lentil, Fusarium wilt of chickpea, alkaloid content of white lupin, and stress tolerance (mainly tolerance to drought) in chickpea and lentil. At the present time the only known systematic screening has been the screening of the core collection of chickpea for resistance to Ascochyta blight at Pullman and the screening of the lentil core collection for resistance to pea enation mosaic virus, also at Pullman. Data from these evaluations have been added to the GRIN database. Accessions of lupin should be tested for alkaloid content, a simple, inexpensive assay. All accessions should be classified with regard to the vernalization requirements as winter, semi-winter, or spring types. These data are partially available from germplasm evaluation studies conducted by Noffsinger (1993) but need to be incorporated into the GRIN database. Lupin accessions, furthermore, need to be evaluated for reaction to Colletotrichum, Fusarium, and Pleochaeta.

***Enhancement***

Wild species, especially those in the primary gene pools of the cool season food legumes, are needed to expand the available genetic variation for growth, yield, tolerance to stresses, and disease resistance. Currently, the wild species are not being used to any great extent in breeding these crops. Introgression of genetic material from the primary gene pool into the genomes of these crops can be accomplished by hybridization followed by selection and backcrossing to adapted cultivars to recover adapted and/or disease resistant types. A continuing effort is required to continually introgress desired traits from the wild species of lentil and chickpea to the cultivated species.

Material available from the International Agricultural Research Centres (ICARDA & ICRISAT) should be obtained and added to existing collections in the U.S. The ICARDA center has chickpea lines with Ascochyta blight resistance and large seed size. These lines appear promising based on performance at Pullman and are currently being evaluated. The ICRISAT program in India has made available ascochyta blight resistant, Fusarium wilt resistant and bean leaf roll virus (chickpea stunt) resistant material for evaluation in the U.S. The ICARDA program has provided selections from interspecific crosses in lentil for further evaluation. This material may have tolerance to heat and drought since the wild species were collected from stony and very dry habitats.

For white lupin we need to develop populations which have imrpoved resiatnce to the three major disease organisms, *Colletotrichum*, *Fusarium*, and *Pleiochaeta*. It is not critical that they are developed in both spring or winter types because these two types are readily crossed in the greenhouse; flowering can be synchronized through judicious vernalization and/or altering the greenhouse temperature during development. It will be important to forge joint ventures with other countries to obtain these goals.

***Preservation***

The seed collections of lentil, chickpea, faba bean, lupin, grasspea and fenugreek at the RPIS in Pullman are stored at 4-5°C and a relative humidity of 30-35%. Also, a backup of these collections is maintained at the National Seed Storage Laboratory (NSSL) at Ft. Collins, Colorado at -18°C and/or under cryopreservation conditions (liquid N). New material from exploration and collection expeditions and other sources is systematically increased and added to the collection.

## V. <u>Recommendations</u>

Germplasm for development of commercially acceptable cultivars of these crops is required if these crops are to remain viable to U.S. agriculture.

***Research Priorities***

1. Evaluate the *Lupinus* collection for response to *Colletotrichum*

1. Continue the evaluation of the *Cicer* collection for Ascochyta blight resistance.

2. Continue the evaluation of the *Lens* collection for resistance to pea enation mosaic virus.

2. Evaluate the *Lupinus* collection for seed alkaloid concentration.

3. Evaluating the *Lens* collection for Ascochyta blight resistance..

3. Evaluating the *Lens* collection for BLRV resistance.

3. Evaluate the *Lupinus albus* collection for response to *Fusarium*

5. Fill gaps in collections of lentil and chickpea by additional exploration and collection in areas poorly represented in our existing collection. Primary areas for additional collection include eastern Turkey, Central Asia, Afghanistan, Iraq, Iran and Ethiopia.

***Level of Support.***

1. Explorations for unique germplasm in the areas mentioned is desirable. An exploration trip to Bulgaria was made in 1996. Contact has been made for a possible exchange of germplasm with Ethiopia and exploration and collection there in the near future.

2. Evaluation of the core collection of chickpea germplasm for resistance to Ascochyta blight was completed at Pullman. Evaluation of accessions in the base collection could be accomplished at an estimated cost of about $10,000 per year for about 500 accessions per year. Emphasis in the screening program is to identify sources of resistance that might be used in the breeding program.

3. Screening of the lentil collection for resistance to pea enation mosaic virus is currently on hold after initial success with the core collection. However, additional evaluations of the base collection could be undertaken with some funding support. Collection of germplasm from countries with a high frequency of resistant lines would likely be very productive.

4. Techniques for evaluation of lentil germplasm for tolerance to drought have been developed and involve the use of laboratory/growth chamber tests followed by field verification. Funds are needed for equipment and labor to initiate this activity.

5. Evaluation of the lupin collection for seed alkaloid concentration and resistance to stated disease organisms can be easily done. This evaluation of the lupin collection would go a long way toward making it more useful to breeders.

## VI. Source of Funding

State Agricultural Experiment Stations cooperate in germplasm activities by providing facilities (laboratories, greenhouses and land for the work). Industry is interested in the work, but generally devotes its limited funds to projects that provide a more immediate return on investment. The major costs of germplasm activities on the cool season food legumes must be provided by ARS.

## VII. Literature Cited

Merrick, L. 1997. Evaluation of Early Maturing White Lupin Germplasm for Northern Latitude Grain Production. 1997 Annual Report for Research Agreement No. 59-5348-6-798 (USDA ARS / University of Maine). CRIS No. 5348-21000-006-04G (Period: April 01, 1996 - September 30, 1998).

Noffsinger, S.L. 1993. Evaluating the potential of white lupin for the State of Alabama. M.S.

Thesis, Auburn University. 111p.

Reeves, D. W., P. J. Bauer, C. D. Monks, D. P. Delaney, C. H. Burmester, and R. W. Goodman. 1998. Ultra-narrow row cotton: tillage, cover crops, and nitrogen. Proc. Beltwide Cotton Conf., January 5-9, 1998. San Diego, CA. (in press). National Cotton Council.

Zhang, X. and J.A. Mosjidis. 1995. Breeding system of several Vicia species. Crop Science 35: 1200-1202.

Zhang, X. and J.A. Mosjidis. 1998. Rapid prediction of mating system of Vicia species. Crop Sci.(In Press).

## VIII. Contributors to this Report

| Contributor | Organization | Location |
|---|---|---|
| L. Merrick | University of Maine | Orono, Maine |
| Jorge Mosjidis | Auburn University | Auburn, AL |
| Fred Muehlbauer | USDA-ARS | Pullman, WA |
| D. Wayne Reeves | USDA-ARS | Auburn, AL |
| Edzard van Santen (ed) | Auburn University | Auburn, AL |
| Chuck Simon | USDA-ARS-W6 | Pullman, WA |
| Al Slinkard | Univ. Of Saskatchewan | Saskatoon, Canada |

http://www.ncaur.usda.gov/nc/ncdb/search.html-ssi