1988

OAT NEWSLETTER

Vol. 39

May 1989

Sponsored by the National Oat Conference

1988

OAT NEWSLETTER

VOLUME 39

Edited in the Department of Crop and Weed Sciences, North Dakota State University, Fargo, ND 58105. Costs of preparation financed by the Quaker Oats Company, Chicago, Illinois 60654.

May 1989

Sponsored by the National Oat Conference

Michael S. McMullen, Editor

TABLE OF CONTENTS

PAGE

I. NOTES

NEWSLETTER ANNOUNCEMENTS AND INSTRUCTIONS

Persons interested in oat improvement, production, marketing, or utilization are invited to contribute to the Oat Newsletter. Previous issues may be used as a guide, but remember that the Newsletter is not a formal publication, and therefore that manuscripts suitable or planned for formal publication are not desired.

Specifically, but not exclusively, we would like to have:

1. Notes on acreage, production, varieties, diseases, etc. especially if they represent changing or unusual situations.

2. Information on new or tentative oat cultivars with descriptions. We want to include an adequate cultivar description, including disease reactions and full pedigree if possible.

3. Articles of sufficient interest to be used as feature articles.

4. Descriptions of new equipment and techniques you have found useful.

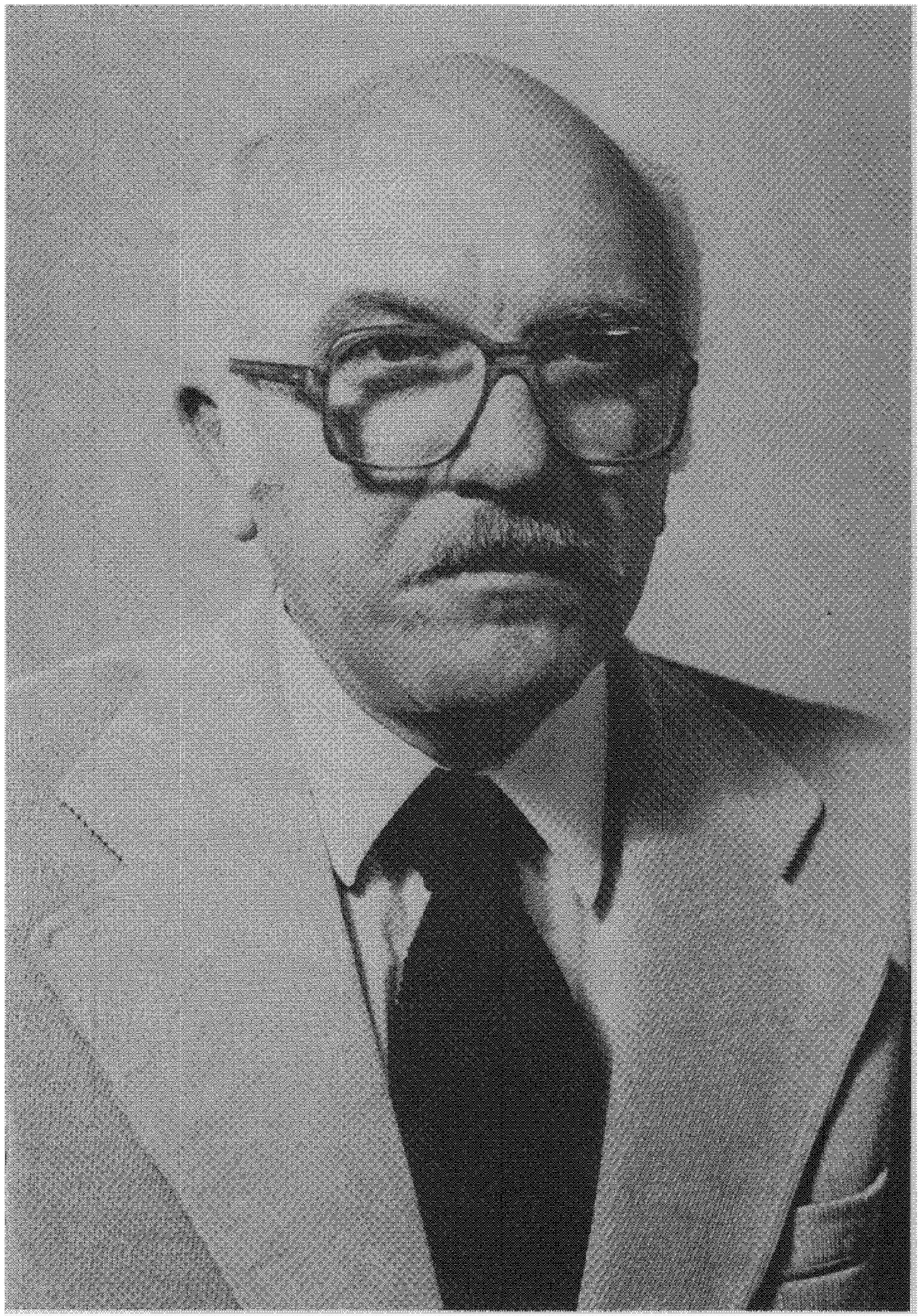
Material may be submitted at any time during the year. Please send all contributions and correspondence to:

Michael S. McMullen
Crop and Weed Sciences Dept., NDSU
Fargo, ND 58105, USA

Please Do Not Cite The Oat Newsletter in Published Bibliographies

Citation of articles or reports in the Newsletter is a cause for concern. The policy of the Newsletter, as laid down by the oat workers themselves, is that this letter is to serve as an informal means of communication and exchange of views and materials between those engaged in oat improvement and utilization. Material that fits a normal journal pattern is not wanted. Each year's call for material emphasizes this point. Oat workers do not want a newsletter that would in any way discourage informality, the expression of opinions, preliminary reports, and so forth.

Certain agencies require approval of material before it is published. Their criteria for approval of material that goes into the Newsletter are indifferent from criteria for published material. Abuse of this informal relationship by secondary citation could well choke off the submission of information. One suggestion that may help: If there is material in the Newsletter that is needed for an article, contact the author. If he is willing, cite him rather than the Newsletter. This can be handled by the phrase "personal communication"



DAVID H. SMITH, JR.

David H. Smith, Jr., Curator of the National Small Grain Collection, Agricultural Research Service, U.S. Department of Agriculture, died on September 7, 1988, at his home in Laurel, Maryland.

Dr. Smith was born in Hibbing, Minnesota, March 7, 1926. He attended Hibbing Junior College from 1946 to 1948, and Hamline University from 1948-1950, where he obtained a B.S. degree in Biology, with a minor in Chemistry. Dr. Smith attended the University of Minnesota from 1950-1955. He was awarded an M.S. degree from that institution in 1955. His major was Plant Pathology and his minor was Agricultural Biochemistry. Dr. Smith obtained his Ph.D. degree from Michigan State University in 1963, with a major in Plant Breeding and a minor in Genetics.

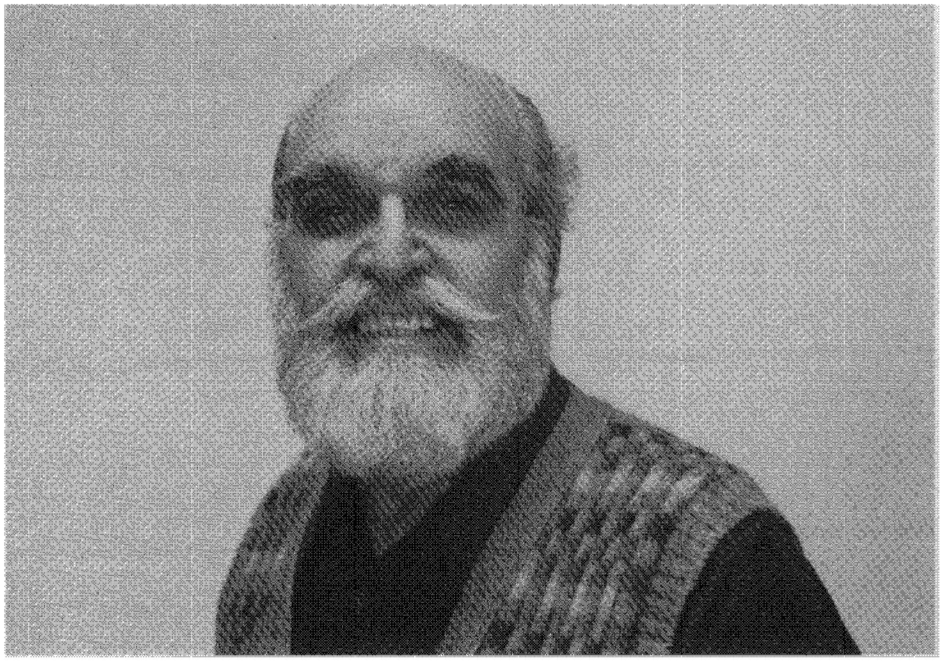
He served as a Biology teacher in Billings High School, Billings, Montana in 1955-1956, and was an Instructor in the Zoology and Botany Department at Brainerd Junior College, Brainerd, Minnesota from 1956 to 1959. He was an Assistant Instructor in the Crop Science Department at Michigan State University while working on his Ph.D. degree.

Dr. Smith began his professional career after graduation in 1963 as Assistant Professor in Research and Extension in the Crop Science Department at Michigan State University, East Lansing, Michigan. In 1965, he was appointed as Research Geneticist with the Agricultural Research Service, U.S. Department of Agriculture, and remained at Michigan State University to conduct research on control of the cereal leaf beetle, Oulema melanopus (L.), which at the time was a newly discovered insect pest that attacked wheat, barley, and oats in the North Central States. His contributions as part of an integrated pest management team resulted in the virtual elimination of the threat posed by this insect to small grain producers in the eastern U.S. Dr. Smith moved to the Beltsville Agricultural Research Center, Beltsville, Maryland in 1980 as Curator of the National Small Grain Collection. He served in that capacity until his death in September 1988.

He was a member of the Crop Science Society, the American Society of Agronomy, and of Sigma Xi. Along with his responsibilities as Curator of the National Small Grain Collection, he served on the Oats, Rice, Barley, and Wheat Crop Advisory Committees.

Dr. Smith was well known for his interest in and his commitment toward helping younger research scientists in their developing careers. During his time at Michigan State University he had the opportunity to encourage and direct several graduate students. He retained contact with his former students and never lost interest in their progress. His interest in teaching continued throughout his career. While at the Beltsville Agricultural Research Center, he frequently interacted with students form the University of Maryland. He often lectured in the Agronomy Department there and served in an advisory capacity to numerous graduate and undergraduate students interested in germplasm issues.

He is survived by his wife, Jeanne Harrison Smith, who lives in Laurel, Maryland; by his sister, Marcia I. Smith of Hibbing, Minnesota; and by a son, D. Erik Smith of Bath, Michigan; and a daughter, Julia I. Smith of Berkeley, California.



JOHN (JACK) F. SCHAFER

John F. Schafer, Research Leader at the Cereal Rust Laboratory (USDA-ARS), University of Minnesota, retired August 31, 1987. He continues as a Collaborator at the Cereal Rust Lab and an Adjunct Professor in Plant Pathology at the University. Dr. Schafer first worked in plant pathology, on wheat bunt studies, as a high school student assistant to the late C. S. Holton at Pullman, WA, in 1936. Following graduate study in plant pathology and agronomy at the University of Wisconsin he began his professional career as an Assistant Professor of Plant Pathology at Purdue University, in 1949, advancing to Professor in 1958. Subsequently, he has served as Plant Pathology department chair at Kansas State and Washington State Universities and, briefly, Integrated Pest Management Coordinator for the USDA Science and Education Administration and Acting National Research Program Leader in Plant Health for ARS, prior to joining the Cereal Rust Lab.

During 19 years at Purdue, Dr. Schafer was co-leader of a research team that developed 30 disease-resistant cultivars of small grain crops, including the oat cultivars, Bentland, Clintford, Clintland, Clintland 60, Clintland 64, Diana, Dubois, Newton, Norline, Putnam, Putnam 61, Tippecanoe, and Tyler. Several of these cultivars were resistant to crown rust, stem rust, and smut and some provided a degree of protection from the yellow dwarf virus. They were particularly noted for their resistance to lodging and physical grain quality. This research team was featured with other oat breeders in the 1961 edition of the ASA monograph Oats and Oat Improvement.

Dr. Schafer taught the general graduate course in plant pathology for many years, and was the plant pathology advisor to numerous Purdue plant breeding graduate students. As a department head he initiated and developed funding for research programs in wheat streak mosaic resistance; remote sensing; resistance to barley yellow dwarf, leaf rust, and dwarf bunt of wheat; and biological control of weed pests.

While on sabbatical leave at Duquesne University in 1965-66, Dr. Schafer participated in ultrastructural investigation of wheat rust infections in the research program of Drs. Howard and Mary Ehrlich. With his Purdue associates, he earlier demonstrated that a high rate of mutation to virulence occurred in the crown rust fungus. Later, at the Cereal Rust Lab he co-proposed a possible theoretical basis for obtaining more durable resistance from pyramiding rust resistance genes.

Dr. Schafer is a long-time member of ASA and CSSA and a past-president and fellow of The American Phytopathological Society. He has authored or co-authored over 200 publications and technical reports and co-authored a section "Genetic Resistance for Crop Protection" in the ASA Modern Crop Science Series book Introduction to Crop Protection in 1979, and was the author of a section "Rusts, Smuts, and Powdery Mildew" in the second edition of the ASA monograph Wheat and Wheat Improvement in 1987.

He and his wife, Joyce, remain in St. Paul participating in University activities and enjoying opportunities for travel.

AMERICAN OAT WORKERS' CONFERENCE

Mark your calendars. The next meeting of the American Oat Workers' Conference is planned to take place during 14 to 17 August, 1990 at the Snow King Resort, Jackson Hole, Wyoming. Invited and voluntary papers will be solicited for the conference program. Tours to the Research and Extension Center and the National Small Grains Research facility at Aberdeen, Idaho and the Tetonia, Idaho Research and Extension Center are planned. Additional information will be mailed at appropriate dates.

Executive Committee

H. W. Ohm, Chairman
D. D. Stuthman, Past Chairman
P. D. Brown, Secretary
M. S. McMullen, Editor

Federal Advisor

D. M. Wesenberg

Representatives

Canada	Mexico	U.S.A.
V. D. Burrows	Navarro-Franco	M. E. Sorrels (NE)
Andre Comeau		H. W. Ohm (NC)
Brian Rossnagel		H. F. Harrison (SO)
		D. M. Wesenberg (W)

At Large

M. A. Brinkman
D. M. Peterson
S. H. Weaver

REPORT OF NOIC LEGISLATIVE COMMITTEE

Deon D. Stuthman

The Legislative Subcommittee of the National Oat Improvement Committee made its 12th successive annual visit to Washington, D.C. on February 7-10, 1989. The current members are Paul Murphy, H.W. Ohm, D.J. Schrickel, and D.D. Stuthman. Ms. Penney Cate from the Quaker Oats Company arranged the Capitol Hill visits and accompanied the group for our entire visit. Dr. C.F. Murphy arranged the group's itinerary for visits with USDA people both in Washington and in Beltsville. This year's trip was sponsored by the newly formed American Oat Association. The Association is an outgrowth of the Milling Oat Improvement Association which sponsored all previous trips. The new organization is broader based and includes over 200 producers in addition to millers, handlers, and researchers.

The goal of the new organization is to increase U.S. production of oats. This goal can be met in two ways: 1) modify U.S. farm program legislation so that it is less unfavorable to oat production, and 2) increase USDA-ARS research allocations to oats to develop a crop which is more productive or more useful, either of which will make the crop more competitive.

Board members of AOA joined in this year's legislative effort and met with key congressional staff to press for a new (probably 1990) farm bill which will have fewer disincentives for oat growers. Agriculture committees from both the Senate and the House as well as congressional staff from key oat producing states received most of their attention.

Our research group continues to advocate increased funding for plant germplasm efforts in ARS generally and also urged appropriation of the additional money necessary to complete the proposed additions to the National Seed Storage Laboratory in Fort Collins. In addition to these general items, we have for the first time made two specific requests for oat research: 1) $200,000 for additional effort on oat germplasm enhancement, and 2) $200,000 for a new USDA cereal chemist position at Fargo, N.D.

The first request would send new resources to Aberdeen, Idaho to fund more germplasm enhancement efforts. Much of the money would be further distributed to other locations according to the germplasm enhancement plan developed and revised by the Oat Crop Advisory Committee. The second request would support a new position which would probably be housed in the Cereal Science and Food Technology Department at North Dakota State University. Most of the effort would be devoted to fiber and beta glucan contents of oats.

The group met with Dr. Dean Plowman, the new USDA-ARS Administrator, for the first time. He was very supportive of efforts to increase U.S. oats production. We also met with the two people (both new) in the Office of Management and Budget who have responsibility for all USDA budgets. The major assignment of this agency is to examine all budgetary items for possible contributions to the deficit reduction to meet Gramm-Rudman targets. We discussed budgetary implications of increased oat research allocations as well as modifications of the commodity programs to increase incentives for oat producers.

We also met with Dr. John Miranowski, Director of the Natural Resources Division of the Economic Research Service of the USDA. He indicated that his group is conducting a major study of the impact of various farm program options on commodity diversity. We look forward to their report.

Our final day was spent at Beltsville with several National Program Staff members. Items discussed include germplasm, beta glucan evaluations, barley yellow dwarf virus, and international disease nurseries.

We welcome any suggestions for other issues that you feel we should pursue. The group appreciates the financial assistance provided by the American Oat Association.

MINUTES OF THE ANNUAL MEETING
OF NCR-15 OAT IMPROVEMENT
LUND, SWEDEN
5 JULY, 1988

The meeting was called to order at 8:00 p.m. at the Hotel Sparta by acting chairman, Herb Ohm (Chairman Marshall Brinkman was unable to attend). Dave Peterson was appointed as recording secretary. During the meeting, experiment station representatives or their alternates in attendance were:

C. M. Brown	Illinois AES
H. W. Ohm	Indiana AES
K. J. Frey	Iowa AES
D. D. Stuthman	Minnesota AES
R. Freed	Michigan AES
W. W. Sahs	Nebraska AES (administrative advisor)
M. S. McMullen	North Dakota AES
D. L. Reeves	South Dakota AES
R. A. Forsberg	Wisconsin AES

Minutes of the meeting of NCR-15 that took place 15 June, 1987 at West Lafayette, Indiana, were read and approved. Dr. Mike McMullen, chairman of the committee to draft the North Central Region Strategic Plan for Oat Research, presented the report for discussion. The report was accepted with the suggestion that individuals communicate concerns, corrections, and suggestions to Dr. McMullen or other committee members (Marshall Brinkman, Dale Reeves, Howard Rines, Gregory Shaner, and Sam Weaver) as soon as possible. Dr. Warren Sahs will present the report to the directors of the North Central Region experiment stations at a meeting in October. Appreciation was extended to the committee for a big task well done.

After extensive discussion about the importance of and need for coordination by ARS-USDA of regional and international nurseries (including rust and barley yellow dwarf nurseries), Chairman Ohm appointed a committee of Bob Forsberg, Ken Frey and Deon Stuthman to draft a resolution to ARS-USDA expressing the need for oat nursery coordination. Herb Ohm will submit copies of the Resolution to Dr. Charles Murphy, ARS-USDA. The Resolution (copy attached) was unanimously approved by NCR-15 at a special session convened on 7 July at the Hotel Sparta, during the 3rd International Oat Conference. In related items: It was reported that Dr. Kurt Leonard is on board as the new Director of the Cereal Rust Laboratory at St. Paul, Minnesota; and that the Marr Simons' replacement position at Ames, Iowa is being advertised. Also, Andre Comeau indicated that he can coordinate the International Oat Barley Yellow Dwarf Nursery one more year.

Election of officers. Herb Ohm, secretary for the past two years, is chairman for the next two years replacing Marsh Brinkman, whose term as chairman expires after this meeting. Dr. Fred Kolb was elected unanimously as secretary for a two-year term after which time he will become chairman for two years.

MINUTES OF THE ANNUAL MEETING
OF NCR-15 OAT IMPROVEMENT
LUND SWEDEN
5 July, 1988

Oat Workers Field Day, 1989. Dale Reeves invited the oat workers to South Dakota. The invitation was unanimously accepted.

Uniform Early and Midseason Oat Performance Nurseries. Howard Rines reminded oat workers that it is preferred that each cooperator send seed of entries to Canada individually and that untreated seed is preferred.

The Quaker Oats Company was recognized for travel support to the 3rd International Oat Conference, and for continued support for oat research.

Administrative Advisor, Dr. Warren Sahs commented that we need to look at oat and oat research from the viewpoint of "value added" because oat has a low grain value in the marketplace. Oat has unique nutritional and chemical properties that we probably have not developed sufficiently and that oat may be a real "sleeper". Dr. Sahs also reminded oat workers that $800,000 of regional funds are being made available to North Central States for research and education projects involving "low input" crops and agricultural practices. Dr. Sahs expressed thanks to The Quaker Oats Company (Dallas Western, Don Schrickel, Sam Weaver) for their continued support over the years.

The meeting was adjourned at 10:00 p.m.

Respectfully submitted,

Marshall A. Brinkman
M. A. Brinkman
Chairman

Herbert W. Ohm
H. W. Ohm
Secretary

Warren W. Sahs
W. W. Sahs
Administrative Advisor

RESOLUTION OF NCR-15
OAT IMPROVEMENT COMMITTEE
TO ARS-USDA
JULY, 1988

Over the past century, state agricultural experiment stations (SAES) and the Agricultural Research Service (or its predecessor) of the U. S. Department of Agriculture (ARS-(USDA) have formed a partnership in research efforts to accomplish vast increases in crop productivity and significant changes in crop quality. In this partnership, certain general responsibilities were assumed by each party to carry out the wide spectrum of research for oat improvement.

ARS-USDA traditionally has conducted research and has provided research services that have had national impact, whereas the SAES have conducted research and have developed technology of more regional and local impact.

An outstanding example of this partnership has occurred in oat research and development. The SAES have assumed responsibility for development of oat varieties, but critical to the breeding success have been the service laboratories of ARS-USDA that provide evaluations of breeding material. Such centralized evaluation facilities are efficient, can afford state-of-the-art equipment, and provide all breeders with essential evaluations. With changes in ARS-USDA personnel and redirection of research programs, it is easy for such service laboratories to disappear.

Whereas, these ARS-USDA service laboratories are critical to the improvement of oat, The North Central Oat Technical Committee (NCR-15) strongly urges the ARS-USDA to continue to support the following service laboratories:

1. The Cereal Crops Research Unit for protein and oil, and other quality components.

2. The Oat Rust Laboratories to discover resistant germplasms, to supply inoculum of rust pathogens, to survey rust biotypes, and to coordinate uniform rust nurseries.

3. The Barley Yellow Dwarf Virus Laboratory to discover resistant germplasms, to test elite oat lines for tolerance to BYD, and to coordinate uniform BYD nurseries.

4. The Oat Genetics Laboratory to coordinate uniform yield nurseries.

Loss of any of these services would have a decidedly detrimental effect on oat improvement with consequent loss to agricultural productivity and competitiveness.

Participants of the
Third International Oat Conference

To participants of the Third International Oat Conference. Our sincere thanks for your assistance to perform a successful meeting. We will particularly address our thanks to Professor Kenneth Frey, the chairman of the international committee.

For the local organizing committee

Bengt Mattsson

The following is a summary of Oat Crop Advisory Committee meeting held November 18, 1988 at Chicago, Illinois. The meeting was hosted by Sam Weaver at Quaker Tower. Members present at the meeting were: Greg Shaner (chair), Bob Forsberg, Charles Murphy, Deon Stuthman, Sam Weaver, and Darrell Wesenberg. Allan Stoner, leader of the Germplasm Resources Laboratory, ARS, Beltsville, was also present.

If anyone has any comments for the Oat CAC, these should be sent to Greg Shaner, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907. Information about the status of oat genetic stocks would be appreciated.

1. Report of germplasm activities in oat for the past year. Allan Stoner made a few comments about the purpose of the activity reports which each CAC has been asked to prepare. They are used by ARS and CSRS administrators as sources of information about germplasm activities. There has been a request that these reports be distributed to deans of agriculture of U.S. universities. The committee reviewed the outline for this report prepared by Paul Fitzgerald, and a rough draft of the report prepared by Shaner. Based upon discussion and suggestions, Shaner will prepare a second draft and send it to all committee members for further comment before preparing a final report.

2. Oat collections from Turkey. Bob Forsberg discussed the status of the oats he and Marr Simons collected in Turkey. The entire collection has three components. One component was collected and retained by Dr. Cetin Tuten, the Turkish collaborator. A second component was collected by Marr Simons. Entries in this component were transferred from the USDA Plant Germplasm Quarantine Center, Beltsville, MD to the USDA Plant Germplasm Station, Iowa State University, in the fall of 1986. Dr. Simons initiated screening of the entries for reaction to crown rust prior to his retirement in December, 1986. The third component, 313 samples (entries), was collected by Bob Forsberg. Most of the entries represent bulk collections of spikelets from panicles of 50 to 150 plants per field or population. Areas sampled ranged from roadside patches to large fields. This third component is still stored in Forsberg's laboratory. Pressures to evaluate the existing *Avena* collection have prevented evaluation of this new material. There was some discussion about the best way to evaluate this new material. If only 10 plants per entry were grown, which would be only a small sample of the total plants collected from each population, this would amount to 3,000 plants. Because most of this material is *A. fatua* or *A. sterilis*, each plant would need to be staked and bagged. Wesenberg said that he might be able to send someone from Aberdeen to Maricopa to assist with the bagging of the plants. Stoner recommended that PI numbers not be assigned to this material until the bulks are evaluated, after which PI numbers can be assigned to individual plants which prove to have some worthy trait. To preserve the greatest potential variability in this material, perhaps each population should be grown as a population, and then placed in long-term storage while more detailed evaluations are carried out for specific traits, such as disease reaction, on a sub-sample of each population.

3. Oat genetic stock collections. Henry Shands is attempting to assemble information on genetic stock collections for all crops and enter data in the GRIN system, in a manner parallel to the system for the general collections. Based upon communications from Doug Brown and Harold Marshall, and the opinions of the Oat CAC members, the state of the oat genetic stock collection is poor. There is no central facility at which genetic stocks are stored. Stocks are kept by individual scientists who have developed or worked with them. It is likely that many older stocks have been lost. Many that reside in individual laboratories have probably not been submitted to the National Small Grains Collection. The committee directed Shaner to send a letter to all oat workers to solicit information about genetic stocks and to explore the possibility of identifying a central site for maintaining these stocks.

4. International contacts. At the meeting of CAC chairs this summer in Beltsville, the point was made that international contacts can be very valuable in germplasm exchange and facilitating collection trips. The list of students mentioned in point 11 could be used as a source of international contacts.

5. Germplasm core. There was considerable discussion about the germplasm core concept, especially how it could be put into practice for the oat collection. Originally the discussion fluctuated between the idea of the core as a minimal collection that encompassed as much genetic diversity in the crop as is practical, or as an assemblage of lines elite for various characters. We finally agreed that a core would be an entity entirely different from an assemblage of elite populations. Stuthman drew the analogy of Noah's Ark to the core collection. The core would be a collection comprised of single accessions from each of a number of different eco-geographical areas, and representing the different species in the collection. The germplasm core would be routinely grown at several locations and evaluated each year for performance and reaction to any unusual conditions. Also, the core would be examined first when a new trait is being sought, e.g. resistance to a new disease or pest. For those core items that appear superior for the trait of interest, one could then retrieve from the collection other germplasm lines from the same eco-geographic area and test these.

The NPS people are quite interested in the concept of a core as a means of reducing the working germplasm collections to a smaller size for routine evaluation and want advice from the CACs as to what to put into the core for each crop. This may help shift money that is now being used for evaluation to enhancement. It is not clear whether for the oat collection the origin of lines is adequately known in order to assemble a core based on original eco-geographic source. In an earlier discussion Shaner had with Fred Patterson about the core, Fred pointed out that in an outcrossing species such as maize, one accession from an area might likely contain a fair representation of alleles from the population, but one accession of an inbred species probably would not. Fred suggested that for purposes of a core, a bulk be made of individual accessions from each eco-geographic area and these bulks constitute the core. The original accessions would still be maintained in the NSGC as individual lines.

A particular difficulty with the core concept as it applies to *Avena*, is the designation of *Avena sterilis* as a noxious weed in the U.S. This may restrict the ability of oat researchers to evaluate this important segment of the genus in the field regularly.

We also discussed the idea of elite populations, which would be assembled as evaluation data are gathered on the entire collection. These would be small samples (about 1%) of the entire collection that are the best for a particular trait, e.g. resistance to barley yellow dwarf virus or stiff straw. Researchers who routinely work with a trait may want to grow an elite population every year, to confirm the original evaluations and to gather more data on performance, especially genotype X environment , including biotic environment (e.g. pathogen strain), interactions. If a breeder wishes to begin working with a trait, or needs more genetic variability for a trait, the elite population would be the place to start. Conversely, if a breeder is faced with finding genetic variation for an entirely new trait (e.g. resistance to a new pest, or a novel nutritional factor) the core would be the logical place to start.

6. Systematic evaluation. Related to the idea of a core and elite populations is the question of systematic evaluation at several locations around the world. The curtailment of the international disease nurseries for oat has hampered the systematic evaluation of germplasm for disease reaction, which is often geographically variable. The committee believes that as part of the core and elite concepts, a coordinated system of evaluation at several locations (probably different locations for each elite population, but all locations for the core) is needed. This would require a person responsible for distributing seed and instructions for evaluation, assembling data, and preparation of an annual report.

7. Status of evaluation of *Avena* collection. The committee reviewed the progress of evaluation of the existing *Avena* collection by Lee Briggle. Wesenberg reported that much of the field evaluation work is complete, but that various seed characteristics have yet to be evaluated. The committee recommended that first priority be given to evaluation of seed weight, groat percent, groat breakage during dehulling (scored visually as low, medium, or high), groat protein, oil, and ß-glucan

content. All of these characters can be measured on the same sample. Second priority is seed weight per volume (test weight). Third priority is number of spikelets per panicle and panicle length.

8. Germplasm evaluation data format. Allan Stoner reported that his lab is providing formatted diskettes for submission of data. This guides the evaluator in collecting the right kind of data, and assures that it will be submitted in the proper format. Curators will be responsible for this.

9. Data on subsets of the *Avena* collection. We had a brief discussion about submission of data on small subsets of the collection to GRIN. Murphy suggested that only data based on systematic evaluation of the entire collection should be put into GRIN. Others expressed the opinion that under some circumstances partial data would be valuable, such as reaction to a novel race or strain of a pathogen, or reaction to an unusual environmental stress (such as drought). Stoner said that GRIN can handle and identify site-specific data. Clearly, there would be no reason to put partial data from a location into GRIN when complete data for the character already exist from evaluation at a primary site, unless the partial data reveal new information about the collection. Stoner said that most CACs believed that they should be involved in clearing data for submission to GRIN. The committee passed a motion that for oat, this responsibility be given to the chair of the Oat CAC, who can consult with other committee members or oat researchers when appropriate. Shaner said that he would place an item about this in the Annual Oat Newsletter.

10. Plant exploration and collection. We discussed the need for further collection work for *Avena*. The opportunity exists now for collection in, or exchange of materials from, China and Russia. Therefore, this should have a high priority. Stoner provided a list of plant exploration expeditions that will be funded by ARS during fiscal year 1989. Although none of these is directed specifically to cereals, we would hope that collectors going to Turkey would take the opportunity to collect oat samples. Forsberg pointed out that collectors should have permits for every species they wish to collect .

THE FIRST OAT SCIENTIFIC-TECHNOLOGY CONFERENCE

Philip Dyck

In the state of Chihuahua conferences are held annually on apple production, storage and marketing as well as occasionally on other crops, but "The First Oat Scientific-Technology Conference" was the first one held here especially and only for oats.

The conference was held at the agricultural Technology Institute (Instituto Tecnologico Agropecuario-ITA) here in Cd. Cuauhtémoc on September 22 and 23. Two hundred twenty-nine people attended, of which 59 were professors, research agronomists and technicians, 154 were students and 16 were farmers. It was considered the largest gathering of people in the western world that attended an oat conference. The Institutes that participated were the Sierra de Chihuahua Oat Seed Producers Association, Sierra de Chihuahua Experimental Farm, Fertilizantes Mexicanos, S.A.; Agricultural Faculty of the Autonomous University of Chihuahua; Agricultural Technology Institute (ITA 24); Integral Rural Development District 006, University of Minnesota, The Quaker Oats Companies of the United States and Mexico as well as representatives of the Secretaria de Agricultura y Recursos Hidraulicos (Dept. of Agriculture and Hydraulic Resources), INIFAP center in Chihuahua and the local farmers.

The topics and the speakers were:

1. Diagnosis of the Oat Crop in the Sierra de Chihuahua. Antonio Comaduran Cordoba.

2. Antecedentes and Evaluacion of the National. Oat Improvement Program. Dr. Uriel Maldonado-Amaya.

3. Contributions to the Oat Improvement Program. Philip Dyck

4. Five New Oat Varieties for the Sierra de Chihuahua. Dr. J. Juan Salmeron-Zamora.

5. Plant/Oat Breeding. Dr. Deon D. Stuthman.

6. Description of Some Technical Components of the Oat Crop. Venancio D. Solano-Romero.

7. Structural Components of the Dryland Oat Crop in the Lower Babicora. Manuel R. Ramirez-Legarreta.

8. Desirable Characteristics of Oats For Oat Meal Production. A. Bruce Roskens.

This was a good conference for all the visitors present. Information was presented for the farmers as well as for the students and the other officials.

OATS PROTEIN CONCERNS

A. Bruce Roskens
Manager, Grain Development
The Quaker Oats Company

During the late 1960's and early 1970's, the Quaker Oats Company invested substantial time and money in the development and promotion of higher protein oats varieties in the United States. This effort resulted in new varieties which were much higher in groat protein. Not only was the protein higher, but this work led to the development of germplasm which was useful for other desirable agronomic traits, such as disease resistance.

During the mid 1970's and early 1980's, less emphasis was placed on protein enhancement, with more emphasis on grain yield and disease resistance. It was known that the U.S. consumer was able to obtain adequate protein from other dietary sources and would not be willing to pay for higher protein in cereals. This, coupled with changes in the food labeling laws from a percent protein label to the U.S. Recommended Daily Allowance label resulted in a deemphasis on protein as a marketing and thus, breeding objective. Now, with the combined effects of steadily declining U.S. oats production, the 1988 drought, increasing human consumption of oats and the new free trade agreement with Canada, we must once again concern ourselves with protein issues.

The Quaker Oats Company requires high protein oats for our products. We are concerned that our product label claims will not be valid if we are forced to use low protein imported oats. We test the protein of all incoming oat deliveries to our mills and are currently blending low protein imported oats to a level acceptable for our product claims. What happens if domestic supplies are again small and we are forced to blend even higher levels of low protein imported oats?

Although protein levels of foreign oats vary greatly, the oats we have tested (Canadian, Swedish, Polish, Argentine) are generally in a range of 10 - 14% groat protein. Domestic oats we have tested in 1988 range from 15.5 - 19%. We buy oats with at least 15% groat protein, and have made all our product claims based on this level. We will have to continue to closely monitor proteins and continue the expensive and time consuming task of blending as long as low protein foreign oats continue to adulterate the domestic supply.

It is unfortunate that U.S. farm legislation has created an artificial shortage of oats at a time of increasing consumer demand, resulting in the need to import oats. We hope that through the lobbying efforts of the American Oat Association (AOA), the production disincentives for oats that currently exist will be corrected in the upcoming 1990 farm legislation, thus negating the need for imports. In the meantime, we encourage the oats researchers here and abroad to continue their extremely successful efforts in oats variety development, not only with the objective of higher yields, but also improved quality.

CEREAL CROPS RESEARCH UNIT

David M. Peterson and Keith D. Gilchrist

We are beginning to screen oat genotypes for β-glucan content. The procedure involves a dilute acid extraction of ground oat groat samples. An aliquot of the extract is injected into a stream of Calcofluor in buffer, which reacts with the β-glucan to produce a fluorescent product. The fluorescence is measured in a fluorometer, whose signal is output to an integrator. Peak heights are proportional to the amount of β-glucan, and β-glucan content is calculated from a standard curve obtained from purified barley β-glucan solutions. After the extracts are produced, the flow injection analysis system is completely automated. In addition, with little extra effort, the samples will be analyzed by NIR reflectance for protein and oil.

We intend to screen through the world oat collection, and data will be provided to the GRIN data base. During this first year we are willing to analyze high priority breeders' samples for β-glucan on a limited basis, by prior arrangement only. After we have completed screening the world collection (12-18 months), we will consider expanding the service for breeding samples. We will continue to analyze breeders' samples for protein by NIR reflectance as we have in the past. Any comments or suggestions are welcome.

Dr. Ronald Skadsen joined the unit February 27, 1989. Dr. Skadsen is a Research Geneticist, and his research will be focused on oat and barley germplasm enhancement. Specifically he will investigate the molecular regulation of genes relating to quality improvement of these two species.

Report on Guildelines for Oat Quality: Barley and Oat Subcommittee of the Western Experiment Committee on Grain Quality

R. S. Bhatty

The Barley and Oat Subcommittee of the Western Expert Committee on Grain Quality has a mandate to evaluate quality data on oat lines submitted to it annually by oat breeders. The recommendations of the Subcommittee along with those of the Subcommittees on Breeding and Diseases are then submitted to the Joint Meeting of the Western Expert Committee on Grain for support of licensing of the line. However, in practice evaluation of the quality data rarely happened. First, few quality data were submitted. Secondly, the Barley and Oat Subcommittee had neither any guidelines nor expertise to evaluate such data. This situation was corrected in 1987 by enlarging the Barley and Oat Subcommittee to include expertise on oat quality (albeit from the food industry), and secondly by appointing an ad hoc Committee to define quality criteria in oat for incorporation into breeding programs.

The ad hoc Committee recognized that oat is a dual-purpose grain, primarily used in animal feeds. In Canada, only about 2% of the crop production is used for edible products such as rolled oat, ready to eat cereals and oat flour, less than 4% is exported and the rest is fed to livestock domestically. Therefore, to obtain information from a wide cross section of the oat industry the ad hoc Committee wrote to several people working on different aspects of oat production and utilization, both in Canada and the United States, to suggest what constituted oat quality in their opinion. Of the 31 people contacted in the government, university and industry, 20 replies were received, including 12 from oat breeders/geneticist/physiologists, 5 from animal nutritionists and 3 from industry/food chemists/human nutritionists. Largely based on these replies, the ad hoc Committee, in consultation with the Western Canadian oat breeders, formulated guidelines which would be applied in the future to oat lines grown in the Western Canadian Oat Cooperative Test. These guidelines, listed on page 3 of this report, reflect quality both in food and feed oats. They are flexible and may be revised at a later date when further information on oat utilization becomes available.

The replies received have been edited to remove personal information, grouped into three sections and compiled. The intention is to bring the collected information together for distribution to those who wrote to the ad hoc Committee in the first place, and secondly to those working in the oat industry at large to give them a wide perspective of opinion on oat quality.

The ad hoc Committee is deeply indebted to those who took time off from their busy schedules and committed their thoughts to paper.

Recommended Guidelines for Oat Quality

A. Hulled Oat
  (a) Seed Quality
  (i) Hull color - white to yellow preferable, but tan color oat will not be excluded until further consultations with the food industry.
  (ii) Groat color - white to cream.

(iii) Plumpness - for uniformity and elimination of thin and double oat. Greater than 50% on 6/64" (about 2 mm) slotted screen, or comparable to the Western check cultivars of oat, Dumont, Calibre and Cascade.
(iv) Thin oat - Maximum 2% through 1.6 mm screen using Laboratory Precision Grader.
(v) Test weight - Minimum 38 lbs/bushel or 47.4 kg/hl.
(vi) Kernel weight - Minimum 28 g per 1000 kernels.
(vii) % Hull - Desirable, 22 to 26% but not to exceed 30%.
(viii) % Hull Produced During Threshing - maximum 5% (influenced by methodology, moisture, seed size, etc.).
(ix) Theoretical Milling Yield - maximum 160 lbs (number of pounds of oat to produce 100 lbs of finished product).

The next three recommendations are of a general character:
(i) Dehulling - moderately easy
(ii) Groat durability - breakage during processing minimal
(iii) Flavor - clean and characteristics of oat

(b) Chemical Composition
(i) Protein (N x 6.25). Target minimum 13% on dry basis.
(ii) Oil. Maximum 10% on dry basis, or comparable to the check cultivars.
(iii) β-Glucan. No recommendation at this stage.
(iv) Lipase activity. No recommendation at this stage.

B. Hulless Oat

The Committee recognizes the potential of hulless oat in food and feed industries, but is of the opinion that more information is needed to assess its acceptability. At the present, there are two licensed cultivars of hulless oat in Canada, Terra and Tibor. The committee recommends that quality in hulless oat be defined as equal or superior to cultivar Terra in:

- Color
- Plumpness
- Kernel weight
- Test weight
- Hulled, %
- Protein
- Oil

Again, as in hulled oat, no recommendations are made at this stage for β-glucan and lipase activity.

C. Recommended Check Cultivars

(a) Hulled oat
Dumont
Calibre
Cascade

(b) Hulless oat

Terra

Appendix 1
<u>Members of the ad hoc Committee on Oat Quality</u>

Dr. G.M. Ballance
Department of Plant Science
University of Manitoba
Winnipeg, Manitoba
R3T 2N2

Dr. R.S. Bhatty (Chair)
Department of Crop Science
University of Saskatchewan
Saskatoon, Saskatchewan
S7N OWO

Mr. D.G. Goslin
Research and Development
The Quaker Oats Co. of Canada Ltd.
Peterborough, Ontario
K9J 7B2

Dr. A.W. MacGregor
Grain Research Laboratory
Canadian Grain Commission
1404-303 Main St.
Winnipeg, Manitoba
R3C 3G8

Dr. J. Noll
Research Station, Agriculture Canada
195 Dafoe Road
Winnipeg, Manitoba
R3T 2M9

Mr. M. Noel
Ogilvie Mills Ltd.
53 Higgins Ave.
P.O. Box 846
Winnipeg, Manitoba
R3C 2R8

Mr. W.M. O'Connor
Robin Hood Multifoods Inc.
191 Attwell Drive
Rexdale, Ontario
M9W 5Z2

Appendix 2. The Replies

Group 1 (Breeders/Geneticists/Physiologists)

1.
(a) Test weight is probably the most commonly used quality trait. It provides an indication of the filling of the groat. As such, it has been used in the grading system and is a factor in determining the financial return to the farmer. Test weight also provides a clue as to the "visual desirability" (plumpness, absence of awns) of the kernels. The visual appearance of the oat sample is important in farm to farm sales of oat. The range of test weights acceptable can be obtained from the grading standards for oat. The 1985 minimum test weight for No. 2 Feed Oat was 41.0 kg/hl. An oat breeder should be able to put out lines higher in test weight than 41.0 kg/hl.

(b) Percent hull is another important quality trait for both human and animal markets. Anything over 25-27% (I favour the lower level) is too high. Measuring % hull is not a fast job if it is to be done accurately.

(c) 1000 kernel weight is useful as another indication of kernel filling. Under prairie conditions it should be possible to get a 1000 k. wt. of at least 30 grams.

(d) Percent plump is a trait that is probably most important in farm to farm sales of oat. Although it provides a measure of the filling of the kernel, it is more useful as an indication of "visual desirability" of the oat sample. This trait is strongly influenced by both the genotype and the environment. Using a 6/64 x 3/4 screen we are usually able to obtain at least 50% plump. This lower range of this trait could be open to much discussion.

(e) For naked oat, I feel that there has to be a minimum tolerance of kernels with hulls still on. This is not as critical for the animal industry but if naked oat was to be used in the food industry it becomes important. I do not know what the level might be. Naked oat may never be more than a specialty item and not significant in the food industry so that a limit on this trait may then not be important.

(f) Percent protein and percent oil are another two important quality characteristics indicative of nutritional and energy levels. Current cultivars have around 4-5.5% oil and 10-12% protein.

(g) As the food industry both in Canada and the U.S.A. are seeing more of the tan hull coloured cultivar Riel, it is becoming increasingly apparent that all the belly-aching about this trait was for nothing. Acceptance of any hull colour seems to be coming. (I have been told that Robin Hood was even willing to accept and use wild oat with a black hull). Groat/flour colour will likely remain critical (dependent on consumer preference) because of its impact on the colour of the final food product. As animal feed, groat colour, unless associated with some other trait, should not be an issue.

2.
A. Physical characteristics

(a) Grain color - While it may be true that hull color doesn't matter, "perception is 9/10 of the law" so to speak and all parts of the market place "prefer" white oat. Therefore, we should restrict ourselves to such. Breeding for this parameter is quite feasible. Unless there is some distinct advantage to an oat of a different color which cannot be transferred to white grain then stick with white.

(b) Groat color - I'm not aware of problems here.

(c) Test weight - A very important parameter which is easy to measure and breed for. Since oat is the only crop which animal nutritionists have demonstrated a real advantage for higher values let us continue to breed for high levels. In western Canada a lowest acceptable level might be ≥ Cascade.

(d) Plumpness - An extremely important parameter from the producer's viewpoint, especially important to seed growers, millers and racehorse feed dealers for cleaning purposes. Easy to breed for therefore let us try to maximize it. The continued use of Harmon across the west for so many years demonstrates the value of this trait. For western Canada, a lowest acceptable level might be ≥ Calibre.

(e) Uniformity - Something a bit newer, but I believe important for any part of the industry where cleaning and sizing is a factor. How easy it is to breed for this we really don't know as it has just now become feasible to even consider investigating this trait via image analysis. Try for maximum uniformity.

Along with this area considerations might be given to shape, size an uniformity of the grain for length to width ratio and also for side to side width/plumpness and dorsal/ventral width/plumpness.

(f) Hull percentage - Obviously an extremely important parameter for feed and milling purposes. However, it is not easy to breed for this trait due to the difficulty in accurate measurement. It is,however, of sufficient value to warrant high priority with some upper limit such that anything higher would be unacceptable. For western Canada, > Cascade would be considered too high in % hull.

(g) Ease of dehulling - This is one of those "rock and a hard place" parameters where you want no peeling to occur prior to receipt by the processor, then you want the material to dehull very easily. Obviously, a happy medium must be struck, however the emphasis should be placed on selection of cultivars which resist peeling and damage during harvest and handling.

B. Chemical characteristics:

(a) Protein - Try to keep this at moderate to high levels, but not at the expense of grain yield. Oat is an energy crop, not a protein crop.

Difficult to handle for breeding.

(b) Oat - Oil concentration should be monitored and moved upward as long as this does not create storage and handling problems. Not difficult to breed for.

(c) beta-Glucans - Obviously a very important parameter for the future but as yet we have no basis from which to work. It may be very difficult to handle this parameter from a breeding point of view unless some quick test procedure can be developed.

(d) Enzyme activity - To be considered in the future if and when required levels are determined, usable genetic variation is found and techniques for measurement are worked out.

C. Hull-less oat - Major problems re storage and handling have not been overcome and <u>must</u> be before this crop can be a viable alternative in western Canada. Major factors include groat hairs, rancidity, degree of hull-lessness and sprouting.

D. Forage purposes - Let us not forget that an awful lot of our oat crop is used as "green feed" forage. Essentially, all of the grain quality parameters (except those of value to seed processors) are of little or no value in that case. For that purpose, yield and agronomic adaptation are the only critical features. However, if a variety were produced with high forage yields and terrible grain quality it would be the responsibility of the breeder to make that very clear. In addition,I have yet to see this magic genotype and see little reason that one cannot produce a high yielding forage oat with good grain quality anyway.

In time, there may be specific forage quality parameters in favour of ADF and NDF as well but currently these are not functional considerations.

<u>3.</u>
<u>(2 Submissions)</u>

A. Physical characteristics of the grain

(a) Test Weight: Should be above 34 lbs/bushel (which is the statutory test weight for oat). Higher test weights are not necessary because test weights about 34 lbs/bushel do not affect the feed or the milling qualities of oat.

(b) Color: Should be white or red but not tan or black. If the grain is tan colored, it would be very difficult to distinguish it from "heat damaged" grain. If the grain is black in color, it would be very difficult to assess degree of contamination by certain ecotypes of wild-oats.

(c) Hull Content: Should be less than 30% with no restriction in lower levels. Current marketing systems for oats do not recognize hull content as an important quality criteria. Many livestock producers are growing oats for its fiber content rather than for energy. A genotype that consistently shows more than 30% hull should not be registered (licensed).

B. Protein Content: Should be more than 10%.

C. Fat Content: Should be more than 4%.

D. Other Factors: ß-glucan, lipase and lipoxygenase are important factors in oat, but should not be considered as quality criteria at the present time. While problems associated with the presence of trichomes and rancidity factors in hull-less oat may deserve research attention in the future, I do not think that there is sufficient urgency to warrant their inclusion as quality parameters at the present time. There is an urgent need for hull-less oat in Alberta as eastern cultivars such as Tibor and Terra are poorly adapted in the province. I would suspect that many producers in Alberta would not be deterred by the inconveniences engendered by presence of trichomes and rancidity factors provided that the requirements for yield, maturity and agronomic characteristics are fully met.
More than 95% of the oat produced in Alberta are used either for livestock feed or for seed (to grow the next crop of oat) and less than 1% is actually used for milling. The new quality standards should reflect current utilization and marketing systems of oat in Western Canada, and should define the quality criteria for milling oat as distinct from the quality criteria for feed oat. In general, the quality criteria for feed oat should not be more stringent than the quality criteria for feed barley.

4.

The concepts and the techniques used to measure grain quality in oat will likely change a great deal over the next 5-10 years. This will occur because the feed and food industries are taking a new look at oat and are examining the different traits which are of interest to them. The ß-glucan gum content is either a blessing or a problem depending upon whether the grain is to be used for human food (lower cholesterol levels) or by animal producers (lower feed intakes, sticky droppings, etc.). High protein content is an advantage to food processors and animal feeders but if this is accomplished at the expense of yield then farmers are dissatisfied. High lipid is beneficial to animal producers but if the grain isn't handled properly it becomes rancid. Low hull percentage is usually preferred but if the grain is dehulled in the combine the food processor discounts such samples. Hull color is an emotional issue with preference being given to white followed by yellow or tan and finally to grey or black. The seed growers like white over yellow because the latter is sometimes confused with weathered grain. Tan color is often confused with "heating in the bin" and black seeds are confused with wild oats and black hulls are though to be insects by housewives, especially in oatmeal.

Bushel or test weight is the measure the grain industry uses to measure grain quality but 1000 KW and percentage hull (or groat) values are more useful. Percent plump kernels is an arbitrary sieving size measure of quality but I question its value.

For covered-seeded entries I think we should report the following when requesting registration.

(a) Total yield (weight/unit area)
(b) Groat yields/unit area (calculated value)
(c) 1000 KW and size distribution (image analysis)
(d) % hull
(e) Groat weight/seed and size distribution (image analysis)
(f) Seed color (white, yellow, tan, grey, black)
(g) Test weight (standard technique)
(h) % protein (N x 6.25) or some other constant (5.7?)
(i) Protein yield/unit area (calculated value)
(j) % lipid (hexane extractable or total?)
(k) Lipid yield/unit area (calculated value)
(l) Metabolizable energy per kg and per unit area (calculated value)
(m) Ease of dehulling (% of seeds dehulled after one pass through a dehuller using a well defined protocol)
(n) % broken seeds after dehulling
(o) ß-glucan content - after a satisfactory assay is devised
(p) Lipase and lipoxygenase activity after a simple technique to measure such activity is devised.

For hull-less varieties we should measure the following.

(a) Groat yield/unit area
(b) % covered seeds in sample
(c) % hull of covered seeds (a measure of how easy it will be to rub the hulls off)
(d) % seeds broken in combining
(e) 1000 KW of groats and size distribution (image analysis)
(f) Test weight from combine or after threshing
(g) Test weight after polishing to remove hair (difference between 6-5 is a measure of hairiness)
(h) % protein
(i) Protein/unit area (calculated value)
(j) % lipid
(k) Lipid/unit area
(l) Metabolizable energy/kg seed and for unit area of land
(m) ß-glucan gum content
(n) Groat color (Develop a color standard and use image analysis to get a measure of color variation ie. some kernels become infected with Alternaria)
(o) Lipase and lipoxygenase activities.

These are the main factors that I see that we should be measuring but I am not suggesting that we require everyone to comply to such a lengthy list for every level of test. I would like to see a movement toward the collection and publication of more meaningful data. For example, total yield is one measure that needs clarification. In a feed grain, groat protein yield and metabolizable energy are very important. We might not be able to raise yields dramatically but you can imagine what a rise of lipid content from 4 to 10 percent would do to ME values/acre (assume equal total weight yields). It's on the basis of ME and protein quality and quantity that we should be comparing the merits of oat, barley and corn.

5.
All candidate lines should be compared to cultivars representing standards of quality and possessing a good potential longevity on the market.

(a) Color: No requirement, but uniformity within the line.

(b) Test weight: Oxford is a bit too low. It should represent the lower limit of acceptation in the future.

(c) Percent hull: Lamar and Woodstock are about as high as one can accept; higher hull should be discriminated against. 1% above Lamar or Woodstock should be refused unless the line has very unusual value, and a guaranteed market.

(d) Groat color: The number of dark-tipped groats should be considered more seriously; a limit should be imposed relative to current standards of the industry.

(e) Groat protein: Not a criterion for rejection; however, equal to Donald or higher should be encouraged.

(f) Dehulling in impact dehuller: Should not be much worse than Donald or Capital. A high dehulling being desired, if Donald dehulls 92%, a cultivar dehulling 89% has dubious value for oatmeal and should be discriminated against.

(g) Lipase, Lipoxygenase: Probably a reduction is very desirable but this is not an important criterion except for hulless oat where it might have a high value. It should be tested more thoroughly in breeders material before one wants to make it an important element of decision.

(h) Groat hair: Very important in hulless oat; it may be early to establish a standard, but 30% more hair than Terra should be unacceptable.

(i) Percent awned seeds and awn size: Standards should relate to the most successful awned cultivars.

(j) Bosum oats: Woodstock has too many. Donald could serve as a standard if we say that a cultivar with 4% more bosum oats than Donald is unacceptable for the Canadian market. However, for cultivars possessing exceptionally low percent hull and other unusual qualities (protein, lipase, lipoxygenase) we should accept up to 6% more bosum oats than Donald as these cultivars might reach special markets.

6.
A. Physical characteristics

White oats are better accepted by farmers and buyers as well, they can better appreciate harvest conditions. Down East, yellow oat seem to be accepted if they are good to very good varieties. Tan brown oat is very appealing to the eye but we have no experience in the marketplace having no variety Down East. Personally, I would not go for it here because it simulates Septoria disease problems. Colored paleas are not acceptable either. Conclusion: all white for food or feed.

Test weight should be as high as possible because it is not related to yield and grain size but related to energy content and lower hull. Also advantageous for transportation.

% hull should be low but not the lowest possible, around 22% for Western and 24-25% for Eastern should be ideal. Percentage of hulless oat within a hulled variety, the hull should not peel at harvest to make a nice attractive sample to buyers.

Furthermore, grain size should be big, at least 50% above a 6 1/2 x 3/4 sieve. The grain should also be long, well filled for a 40 grams per 1000 kernels weight. Primary and secondary kernels should be ideally of equal size, no tertiaries.

B. Characteristics for milling quality in oat

Highest test weight, low hull, disease free (no black caryopse), clean oat seem to be the requirements.

C. Levels and ranges of chemical components

Protein: intermediate to high, i.e. 12-16% whole grain, higher if not at expense of yield.

Oil: intermediate to high, i.e. 5-8% whole grain, higher if not at expense of yield.

ß-glucan: no opinion.

Ratio amylose/amylopectin: should be studied genetically. May have to select for higher amylopectin for specific food requirements.

D. Importance of enzyme

No opinion, except for post-harvest dormancy which is necessary.

E. Hulless oat, their importance in swine and poultry feed

Main problem is yield, not economical to produce for sale. It is now fairly well documented that oat is better suited than other grains for poultry and swine. Hulless oat for these purposes will remain a small one-the-farm business and won't enter the market place unless two breakthroughs are achieved: baldness or near it and high yield. In the first case, near baldness can be achieved (probably) by conventional breeding in exploiting the genetic variability present (selection methods need to be designed). To achieve high yield is something else, intergeneric crosses with wheat or barley may be an avenue, with progress made in embryo rescue. Straight breeding will never achieve it because rate of progress is slower than the ones in wheat and barley.

7.
(Joint submission by three persons)

A. Physical characteristics of oat grain.

(a) Grain (hull) color.

Solid colors including shades of yellow, shades of tan, and shades of white are readily acceptable. Shades of black, shades of red, or gray-striped are usually unacceptable to industry because pieces of dark-colored hull create the impression of rodent feces in porridge.

(b) Test weight

This trait is influenced by environment and therefore varies from location to location and year to year. Selections with long-time averages below 35.0 lbs/bu would probably not be competitive with existing cultivars.

(c) Groat percentage

This trait also is influenced by environment. Values below 70% would be unacceptable in some geographical regions, while in other areas values above 65% would be acceptable.

(d) Awns

Presence of awns is influenced by genotype and environment. Care must be taken that awns do not cause an erroneously low test weight reading. Awns do not lower the nutritional or physical quality of grain whether used for feed or food.

(B) Characteristics of milling quality.

(a) Milling yield

Industry establishes acceptability on cultivar and geographical bases. Groat percentage is the primary trait influencing milling yield.

(b) Bright, clean groats

Groats completely covered by hull (lemma and palea) are protected from moisture and fungal growth which cause groat discoloration. Resistance to

Septoria and halo blight minimizes seed infection and subsequent groat discoloration.

(c) Groat durability

A new trait with cultivar differences only recently discovered. No standards established at this time.

(d) Ease of dehulling

Determined by genotype, environment, and especially by groat percentage. Nonplump, hully kernels are more difficult to dehull.

(C) Levels and ranges of chemical components

(a) Grain or groat protein concentration (percentage)

No bounds established. Kernel plumpness, i.e. amount of carbohydrates present, test weight, and groat percentage must be considered when assessing protein concentration. Groat and grain protein concentrations of 20 and 16%, respectively, would be considered high (superior).

(b) Protein composition

There appears to be minimal genetic variation for amino acid composition of oat protein. The quality of oat protein is excellent.

(c) Oil

Oil concentration within *Avena* ranges from 3 to 12%. Most current cultivars contain from 4 to 9%. Oil levels above 10% would be viewed with caution by the food industry until it was certain that grain and groat storage characteristics and industrial milling processes were not adversely affected by the higher oil level.

(d) ß-glucans

Research on ß-glucans is only beginning. Genotypic variability remains to be quantified. There may be dichotomy between desired levels of ß-glucans for food (high) and feed (low).

(D) Enzymes

Upper levels of lipase or lipoxygenase have not been established. Research on functional aspects and on enzyme level x oil level interactions is just beginning.

(E) Hull-less oat

Hull-less oat could become a very useful feed and food if several important problems are solved. Most of these problems will require genetic modification, which in turn requires genetic variability. Equally important will be changes in crop production and harvesting procedures which must occur at the farm level. It will be important to establish high standards so that the reputation of oat as a nutritious, economical food and feed crop is maintained.

Characteristics required include:

(a) Glabrous (bald) groats

Genetic variability does exist. Decreases in density and length of groat trichomes are expected through conventional breeding and selection.

(b) Hard-surfaced groat pericarp

Ease of handling groats will be improved if the pericarp is hardened. Groats will clump less and flow more smoothly in handling and storage. May be less susceptible to rancidity, because of less damage during handling. Range in genetic variability remains unknown at this time.

(c) Preharvest sprouting

Hull-less kernels are more susceptible to preharvest sprouting and activation of endosperm enzymes due to moisture than are tightly hulled genotypes. This problem can be minimized by the incorporation of genes for seed dormancy.

(d) Incomplete dehulling at harvest

This factor is influenced by genotype and environment. Decreasing the proportion of hulled kernels in the harvested crop to very low levels through breeding is an obtainable goal.

(e) Rancidity during storage

Adverse changes during storage will be minimized as more wheat-like groats are developed. Packing and heating within groat lots will diminish as genotypes with glabrous, hard-surfaced groats with some degree of dormancy are developed.

8.

A. Physical Characteristics

Hull color - Bright, white oat is generally preferred, particularly in horse feed markets as a quality assurance that grain has not been weathered and is free of fungal spores. Premiums ranging from \$.15-.50/bu are normal for white vs. nonwhite oat heavy enough for use for "racehorse" oat. Color not as important in human food market, but still appears to be a quality assurance factor to buyers.

Test weight - Test weight is the most widely recognized quality factor used by producers and buyers in assessing the value of oat. A test weight of 38#/bu or greater seems to be recognized as high quality in the premium oat markets. There may be little advantage in trying to produce oat with test weight greater than 42#.

Oat to Groat ratio - The groat percentage is important in determining milling yield of oat for the food industry and for determining digestible energy of animal feed. Most good quality oat cultivars consistently produce groat content in the 75-80% range. Test weight is not always closely related to groat percentage among genotypes. Groat content is very important in determining milling quality.

Presence or absence of hulls - Millers have indicated they prefer to receive oat with the hulls on to prevent dirt from adhering to the groat. However millers are expressing some interest in hull-less oats but their place for use by the U.S. oat milling industry is still uncertain. Whole oat should remain the preferred feed for some classes of livestock which have lower energy requirements, but hull-less oat is likely to be preferred for feed of livestock with high energy requirements.

B. Characteristics of milling quality oat:

Characteristics of milling quality oat are related to milling yield which the millers describe as the amount of whole oat required to produce 100# of product. Milling yield is closely related to groat percentage. The quality characteristics recognized for milling quality oat are: 38# test weight, > 96% sound cultivated oat, < 0.1% heat damaged oat < 1.5% foreign material, < 13% moisture, 0% residue, 0% excreta, 0.9% barley, and 0% live infestation. Test weight is really the only one of these characteristics that can be impacted by to any extent by breeding. Groat percentage is relatively highly heritable and can be changed by breeding, but is not directly considered by buyers in the current marketing system.

C. Levels and ranges of chemical components:

Protein content - Protein contents of cultivars grown in North Dakota typically range form 10-18% on the whole oat as is basis and from 13-22% on the groat as is basis. Increased protein content may be more important for animal feed use than for human food use as cereals are not usually considered as a source of protein for human consumption in the U.S. Producers of horse feed seem interested in protein content, but only guarantee 11-12% protein in their product. However, some have indicated they would prefer a higher protein oat. In our breeding program we have tried to maintain a minimum of 17% groat protein under environmental conditions in which 'Moore' produces about 18% groat protein.

Beta glucan - Beta glucan content is becoming increasingly interesting relative to human food use, but techniques are not available for rapid determination of beta glucan content for use in a breeding program. Little is known about the effect of increasing beta glucan content on feeding quality. For the present time I do not expect to try to manipulate beta glucan content until better analytical techniques are available and the effect on feeding quality is better understood.

Oil content - Our current germplasm normally ranges from 5-9% groat oil content and there appears to be considerable variability available to increase oil content. Increased oil content would increase the energy value of oat as a livestock feed, but may be undesirable in the human food market because increased likelihood of rancidity in stored grain.

D. Importance of lipase and lipoxygenase in milling of oat:

The activity of these enzymes becomes very important when considering naked oat in which the groat is vulnerable to injury and results in activation of these enzymes. The value of high oil oat for the human food industry could likely be increased if the activity of these enzymes could be controlled by means other than heating.

E. Hulless oat:

Hulless oat could likely become important in the feed industry, particularly in areas which have a deficit of high energy feeds such as southwestern North Dakota. They are attractive because they would fulfill both energy and protein needs of many classes of livestock. Variability in the amount of trichomes on groats suggests that some of the handling problems of hulless oats may be remedied by developing cultivars with a lesser degree of trichomes on the groat. Fewer trichomes should result in increased test weight and reduced handling problems.

9.

A. Color

(a) Traditionally white and yellow hulled would both be acceptable, actually preferred to brown or "red" oats. U.S. and perhaps Canadian race horse people have a strong preference for white, probably because they have difficulty distinguishing between any non-white hull and weathered oats

(b) Test weight/groat %. Test weight is still the standard of the oat market, although millers and others are finally starting to realize that oat-to-groat ratio is a much better indication of milling yield. Perhaps before long, people who feed oat to livestock will come to realize that groat % (oat-to-groat ratio) is a better indicator of feed value than is test weight, but for now they use only test weight. As long as test weight and groat percentage are correlated, they will not suffer; however, there are exceptions to the correlation, probably the most notable of which is the variety 'Ogle'.

B. Hull-less

For a long time, almost everyone ignored hull-less oat. Recently, however, interest in hull-less oat has reemerged mostly due to the efforts of Vern

Burrows at Ottawa. With the release of Tibor, Vern has rekindled interest, at least mine and that of a few others, in reexamining the potential of hull-less oat as a superior (to hulled oat) animal feed.

C. (a) protein - commercial range seed basis 8-17%
- groat basis 13-22%
- experimental as high as 30+ on a groat basis

(b) oil - commercial groat basis 4-10%
- experimental 13+%

(c) ß-glucan- see Dave Peterson at CRL at Madison, Wisconsin

10.
A. Physical characteristics of oat grain

(a) Kernel size - While oat spikelets contain primary, secondary and sometime tertiary kernels, large, plump kernels are desirable. Breeders can contribute to this,but so does the environment. Test wt. may or may not be a measure of this, depending how the kernels pack. 1000 kernel weight may be a better measure, although it is not used in the U.S. Grain Standards.

(b) Test weight - U.S. Grain Standards cite #1 oat as 36 lbs/bu, although I believe oat is sold on the basis of 32 lbs/bu. This is a credit to the breeders.

(c) Color - I do not see color as a major factor, although in the U.S. horse breeders, particularly race horse breeders, demand plump, white oat for feed.

(d) Oat to groat ratio - This is very important. In *Avena sativa*, I believe typical values range between 68% to 75% of the oat kernel as groat. This should be a major criteria of quality. The food industry wants a high percentage of groats, because this will give them a much better milling yield. Some companies calculate their milling yield on how many pounds of oat is required to produce 100 lbs. of rolled groats. Care must be taken by oat breeders to be sure that the plump kernel they are looking for is completely covered by the hull - sometimes the tip of the groat can be exposed which makes it more susceptible to disease and weathering, hence discoloring.

(e) Presence or absence of hull - In the past I have asked commercial oat millers if they would not rather receive hull-less oats to save dehulling. Generally they prefer not. As one miller stated, "It's nice to have each groat gift-wrapped." They get a cleaner, more disease free, better colored groat. Oat for feed presents a different story.

B. Characteristics of milling quality in oat - Most of the factors discussed in #1 would apply here. Their major concerns are good, sound groats and good milling yield. Double oats are very undesirable because they essentially reduce the percent of groats in the oat.

C. Chemical components in oat - Breeders in the U.S. have put forth some effort over several years to increase protein levels in oat. This is justifiable because oat protein is of exceptional quality (good essential amino acid balance), and this quality is not affected greatly by increasing crude protein levels. Unfortunately, grain yields to the farmers may be reduced, and historically no protein premium has been paid (as in wheat). Crude protein values of 15-20% (d.b.) would be desirable.

Oil in oats is highly heritable, and I believe Canadian breeders at one time were doing some selections for high oil. While high oil would be a good energy source for animals, it would not be popular in oat for food. The quality of the oil is good (quite unsaturated). Oat does have the highest oil concentrations of the cereals, but I doubt that breeding efforts could raise the level sufficiently to make oat a source of oil that could compete with true oilseed crops.
I have no feel for ß-glucans. I believe they contribute to the food quality of rolled groats when used as a cooked cereal. While ß-glucans present a problem in barley in the malting and brewing, I am not aware that they present problems in oat.

D. Enzymes - The key enzyme is lipase. It starts the ball rolling for development of rancidity, and it is extremely active in oat that have been ground or damaged. Industry handles the problem well with heat treatment. I recall several years ago when the variety 'Dal' was released, industry was much concerned. It was a high protein oat and also had high oil (8-9% free lipids). They were concerned that all high protein oat would also be high oil. We pursued the problem with several hundred samples and found no correlation. It turned out the extra oil presented no additional problem in rancidity.

As to breeding for low lipase, Frey and Hammond (1975. J. Am. Oil Chem. Soc. 52: 358-362) reported a 20-fold variation in lipase activity among 352 oat collections. Perhaps breeding could be done on this with precautions as to what other quality factors are affected. At this point I see no value in including levels of lipase in quality standards until proof is shown that lower levels of lipase will produce lower rancidity. Again, this is no big problem for industry but could be a factor for oat groats from hull-less oat as feed on farms.

E. Hull-less oat - I see these oat as being a real asset to farm feeding, especially non-ruminants. My understanding is that these varieties generally suffer form low yields and are a bit more susceptible to diseases. Lipase action in oat groats is very low unless the groat is damaged or ground (Welch, 1977. J. Sci. Food Agric. 28: 269-274).

I am not very familiar with the problems contributed by trichomes, except the comments made by oat millers.

Generally, oat quality factors apply to both oat for food and feed. One exception might be the lipids.

Group 2 (Animal Nutritionists)

1.
Regarding criteria that should be used to indicate oat quality, the following are suggested:

Fibre, as crude fibre, ADF, NDF
Density, as wt/bu, plumpness, % hull
Crude protein, perhaps ether extract (fat)
Lysine
Digestible energy, total digestible nutrients. These values could be estimated by use of appropriate formulas selected from the literature. Each animal species requires a different formula. Most use crude fibre or ADF, crude protein, sometimes fat and ash. For swine NDF seems superior to ADF.

Some feel that feeding trials should precede licensing of new cultivars. I am not convinced of the necessity for this, given the relative absence of toxic factors, growth inhibitors, etc. in oats. Differences in % fibre (hull), CP, lysine, DE (fat, hull) are likely the main determinants of feeding value. Oat of higher DE content might find their way into rations that now exclude oat but we should remember that oat is often used because of their hull, fibre or DE characteristics, e.g. in horse feed, cattle where high energy grains could be harmful, etc.

2.
(Joint submission by two persons)

Oat as livestock feed

The basic problem with oat is that they are often overpriced compared to barley for feed. As you mentioned, oat is largely used in ruminant diets, and likely more are used on farms than through the feed industry. I understand that part of the value of oat is the quality of fiber in the hull. A significant portion of the alfalfa-pellet market (Japanese) is related to its NDF component more than protein and possibly this could also be exploited in oat (??).

Presently the use of oat by local industry is rather limited. Oat groats are a traditional component of weanling pig diets, although their benefit is often challenged. A local company dehulls oat, with the groats going into weanling pig diets, and the hull being used in calf starter.

Oat groats should be ideally suited to the poultry industry due to their high oil and high protein content. In western Canada, an earlier introduction of hulless oat (Terra) suffered from glucan-related problems in broiler diets. Although levels were quite low (3.00%), extract viscosities were high and feeding value was severely depressed in young birds. There appears to be considerable interest in Eastern Canada regarding the recently introduced hulless oat. It doesn't appear to have the same ß-glucan problems (environment or genetic?) as we experienced with Terra, although there have been indications it is there.

3.

(a) The hull content of oat is very high. As a result chick performance is considerably reduced when the diet contains a high content of oat. This problem can be overcome by using a hulless oat or by dehulling the oat. The former source would be preferred.

(b) The oil in dehulled oat tends to become rancid which has a very negative effect on appetite. Selection of oat with a lower amount of polyunsaturated fatty acids (linolenic) or use of antioxidants would eliminate this problem.

(c) A third problem is that oat appear to have a rather high content of the water-soluble ß-glucans which are highly viscous and as a result interfere with digestion and absorption of nearly all nutrients particularly lipids and the fat-soluble nutrients. This problem can presumably be overcome by selection for cultivars with a low ß-glucan content or by the incorporation into the diet of an enzyme preparation that eliminates the viscosity producing factor.

There may be other problems that we are unaware of but in our opinion these are of prime importance.

Group 3 (Food Chemists/Human Nutritionist)

1.

My interest lie in food uses, and so these qualities that might help overcome traditional constraints in that area interest me most. The traditional constraints are:

(a) Presence of hulls
(b) Necessity for heat treatment to inactivate lipase/lipoxygenase
(c) Lipid throughout kernel causing milling and storage problems
(d) No strongly identified value-added end-product such as wheat has in bread, or barley in beer.

I am unable to provide you with specifics on points 1-3 but for 4) I would say oat now has a promising new food use and that is as a source of soluble dietary fibre (df). To enhance this quality the kernel should have both high ß-glucan (or df) and thick outer sub-aleurone endosperm cell walls (major source of the ß-glucan). I would suggest:

(a) ß-glucan content > 5%; total df > 12%
(b) Ability to produce, through milling and particle size fractionation, a coarse fraction containing >15% ß-glucan and total df > 35% (NB There is no recognized test for this milling-fractionation requirement).

These levels are based on what I know to be feasible rather than knowledge of physiological or functional necessity.

For poultry feed the opposite is needed. Assuming a hulless cultivar is used, then problems similar to those of barley may be encountered. Thin cell walls, low ß-glucan content and high ß-glucanase activity are desirable.

2.

A. Physical Characteristics

Colour - White or light colour - discoloured, grey or tan colours are not desirable characteristics in the oat groat.

Test Weight- Higher test weight is preferred. 38 lb would be considered minimum - range of 38-42 lbs per bushel would be desirable.

Moisture - Lower moisture is preferred. Preferred range is 11.0-13.0%. Maximum should not be higher than 14.00%.

Oat to Groat Ratio - Lowest percentage of hull is preferred. Best is 20%, while 30% is considered poor. 20-26% is a good range. Percentage hulls is related to test weight. The lower the test weight, the higher the hull content seems to be.

Presence or Absence of Hulls

Presence of loose hulls means these become dockage. It also indicates that a lot of dehulled groats are present. In the cleaning process and size separation, these dehulled groats will be lost to feed because of size. Most of the dehulled groats also become dirty which is not a desirable attribute. Loose hulls are not a desirable attribute.

B. Characteristics of Milling Quality Groats:

Plump, clean, no foreign seeds, free of mildew or weathered seeds, frost free, no ergot, clean flavour without any rancid notes, and uniform size are all desirable characteristics. Pin or stub oat end up in feed. Bosom or double oats are also a problem. Any size smaller than 5/16" is definitely not preferred. Also, oat with less trichomes is preferred.

C. Chemical Components:

Protein content 13.50% minimum. Higher levels are desirable.
Oil content - this has not been considered as a prime requirement, although it has influence in keeping quality and flavour. Current levels seem to be quite acceptable. 7-9% is an acceptable range.

Other components have not been considered.

D. Enzymes:

Lower levels of lipase and peroxidase are desirable characteristics. In current processing these enzymes are deactivated, but an attempt in a breeding programme to keep these enzymes at a lower level, if possible, would be a plus for processing.

E. Hull-less Oat:

The obvious advantages in using hull-less oat is that there is no disposal problem with hulls. In a hull-less variety, all the oat must be hull-less, otherwise problems will occur in separating the two. Hull-less varieties are also known for ease of development of rancidity, and handling problems have been associated with hull-less oats. Variety of hull-less oat with less trichomes, no hulls and resistance to rancidity development would be desirable characteristics.

3.

I believe that the "Ad Hoc" Committee established to define oat quality is an important step in ensuring improved oat cultivars. Since my background is in the Human Nutrition area, I will limit my comments to this area. The importance of dietary fiber for general health is now generally recognized. Oat and barley are somewhat unique in this regard since these grains contain the soluble fiber called oat gum or ß-glucan. This soluble fiber component contributes to oat hypocholesterolemic properties and may help in control of blood sugar. Keep in mind that these positive effects of oat fiber for humans may have negative implications for animals since feed efficiencies may go down with higher fiber content. Oat is generally considered as an excellent source of grain protein and contribute modest amounts of some B-vitamins and a few minerals. However, the phytic acid content in oat is high and generally can reduce bioavailability of minerals such as Ca, Zn, and Fe. An oat cultivar high in dietary fiber and low in phytic acid would be very useful. An oat cultivar which is high in dietary fiber and which provides a coarse milling fraction containing most of the groats total dietary fiber would also be attractive.

Survey of the Sexual and Asexual Populations of *Puccinia coronata* in Eastern Canada in 1988

J. Chong

Crown rust caused by *Puccinia coronata* Cda. is an important disease of oats in Canada. In Ontario and Quebec, the combination of favourable weather, the use of susceptible cultivars, and the widespread occurrence of the alternate host, *Rhamnus cathartica* L. (European buckthorn) has resulted in heavy infections and crop losses in some years. The most economical means to control the pathogen is through breeding for resistance. However, the pathogen is highly variable. For instance, the cultivar Woodstock (containing gene Pc39) was highly resistant when it was released to Ontario growers in 1982, but by 1987, it was susceptible to over 55% of the isolates. The widespread occurrence of buckthorn in Ontario is not only important in providing the primary inoculum to this area, but this also allows the overwintering fungus to complete the sexual stage of the life cycle, creating more variability in the population. To look into the latter aspect, a survey was carried out to determine whether isolates from the buckthorn population corresponded in virulence to those from the asexual population on oats.

The low incidence of crown rust in 1988 resulted in very few field collections made from oats in Ontario and Quebec; a total of 63 single-pustule isolates were established. The frequency of virulence of these isolates is shown in Table 1. It is evident that the major shift in virulence to gene Pc39 since 1986 continued into 1988; over 87% of the isolates were virulent on plants with this gene. Using 16 single-gene oat lines as differential hosts (omitting Pc58, Pc59, Pc60, and Pc61 in Table 1), 19 virulence combinations were identified: 14 were isolates with virulence to Pc39 and other Pc genes (Table 2). The most prevalent isolates were virulent on Pc39 and Pc55; Pc35, Pc39, and Pc55; Pc39, Pc55, and Pc56; and Pc35, Pc39, Pc55, and Pc56 (Table 2).

From the aecial collections, 109 single-pustule isolates, comprising 31 virulence combinations, were identified. Seventy-three percent of the isolates, comprising 20 virulence combinations, were ones with virulence to Pc39 and other Pc genes (Tables 1 and 2). Similar to the asexual population, the highest frequency of virulences occurred on lines with genes Pc35, Pc39, Pc55, and Pc56, but virulence was also high to gene Pc46, not found in the asexual population. Despite this difference, the most common isolates in the sexual population were essentially similar in virulence to those found in the asexual population described above.

Several isolates were found in the sexual and asexual populations that were virulent on oat lines with both genes Pc38 and Pc39 (Table 2). However, only two of these were virulent on Dumont, which contains a third undetermined gene for crown rust resistance.

Table 1. Frequency of crown rust isolates from oats and buckthorn virulent on oat lines containing single genes (Pc) for crown rust resistance.

	Oats		Buckthorn	
Resistance gene	No. of isolates	% of isolates	No. of isolates	% of isolates
Pc35	26	41.3	41	37.6
Pc38	1	1.6	4	3.7
Pc39	55	87.3	79	72.5
Pc40	4	6.3	13	11.9
Pc45	4	6.3	1	0.9
Pc46	4	6.3	26	43.9
Pc48	0	0.0	0	0.0
Pc50	1	1.6	8	7.3
Pc54	0	0.0	1	0.9
Pc55	55	87.3	79	72.5
Pc56	22	34.9	58	53.2
Pc58	0	0.0	0	0.0
Pc59	0	0.0	0	0.0
Pc60	0	0.0	0	0.0
Pc61	0	0.0	0	0.0
Pc62	4	6.3	0	0.0
Pc63	0	0.0	2	1.8
Pc64	3	4.8	0	0.0
Pc67	1	1.6	6	5.5
Pc68	0	0.0	0	0.0
Total	63		109	

Table 2. Frequency of Pc39 virulent isolates identified from oats and buckthorn collections in 1988.

	Oats		Buckthorn	
Isolate formula (susceptible Pc genes)	No. of isolates	% of isolates	No. of isolates	% of isolates
39,55	18	28.6	13	11.9
35,39,55	11	17.5	6	5.5
39,40,55	1	1.6	-	-
39,46,55	1	1.6	1	0.9
39,54,55	-	-	1	0.9
39,55,56	6	9.5	21	19.3
35,39,46,55	1	1.6	-	-
35,39,55,56	9	14.3	9	8.3
35,39,55,67	-	-	1	0.9
38,39,55,56	-	-	1	0.9
39,40,55,56	-	-	2	1.8
39,45,55,56	1	1.6	1	0.9
39,46,55,56	-	-	2	1.8
39,46,55,67	1	1.6	1	0.9
39,50,55,56	-	-	3	2.8
39,55,56,67	-	-	1	0.9
39,55,62,64	1	1.6	-	-
35,39,40,55,56	-	-	1	0.9
35,39,45,55,56	1	1.6	-	-
35,39,46,55,56	-	-	6	5.5
38,39,40,50,55	1	1.6	-	-
38,39,46,55,63	-	-	2*	1.8
39,40,46,55,67	-	-	1	0.9
39,55,56,62,64	2	3.2	-	-
35,39,40,46,55,56	-	-	1	0.9
35,39,45,55,56,62	1	1.6	-	-
35,39,46,50,55,56	-	-	1	0.9

* also virulent on Dumont

THE RUST OF OATS IN THE UNITED STATES IN 1988

A. P. Roelfs, D. L. Long, D. H. Casper and M. E. Hughes

Cereal Rust Laboratory

Oat stem rust - In early April a single overwintering oat stem rust focus was found in a south Texas nursery plot, however, no rust was observed in commercial fields. Normally stem rust is found in nurseries and some fields at this time. Oversummering of the rust was limited by the dry summer in 1987. This was followed by a dry fall and winter resulting in few dew periods for rust infection of the seeded crop. The numbers of fall infections were further reduced due to late crop emergence and associated lower temperatures and less inoculum. Stem rust was found in southern Louisiana in early May and central Texas in late May, this is a month later than normal for central Texas. During mid-June traces of oat stem rust were found in plots and fields in northcentral Kansas and southcentral Nebraska. Then by early July stem rust was found in the northern oat growing area of Minnesota, Wisconsin, and the Dakotas. However, the infection frequency was erratic and very low. The lack of rust infection was due to the few spores arriving from the south and hot dry weather which was unfavorable for rust infection and plant growth.

With the exception of the Great Plains the only rust reported was from nurseries in Tifton, Georgia, May 15, Dane and Monroe counties in West Virginia in late May and in Solano and Yolo counties in California.

The rust in the Great Plains was primarily race NA-27 (94%), while the isolates from California were NA-5 and NA-10 (Table 1). NA-5 was also found in West Virginia. In both Oregon and West Virginia isolates were obtained that produce infection types of 2 or less on all oats tested.

Oat crown rust - No crown rust was observed or reported in April surveys throughout Texas and only traces were reported in Alabama and Georgia. By mid-May the aecial stage of this rust was found on buckthorns (alternate host) growing in southern Wisconsin and southeastern Minnesota. In mid-June traces of crown rust were found in plots and fields in the northern oat growing area. By mid-July the hot dry weather retarded further rust development in the northern areas, and the only rust found was in central North Dakota irrigated oat plots. This was probably the least amount of crown rust observed in the past 20 years. Due to the little rust in the Puccinia pathway, the inoculum produced on buckthorns may now be a significant portion of the population. Whether uredospores from the sexual population will become established in the southern overwintering area is unclear. However, if established a shift in virulence patterns could occur.

Rust losses - A summary of rust loss estimates made by the State Departments of Agriculture, University extension and research projects, Animal and Plant Health Inspection Service, Agricultural Research Service, and the Cereal Rust Laboratory as compiled by David L. Long are shown in Table 2. Acreage harvested and yield and production records were based on the 1988 Annual Crop Summary, Agricultural Statistics Board, USDA. Losses were calculated for each rust using the following formula:

$$\frac{\text{(Production) X (Percent loss)}}{\text{(100\%) - (Percent loss due to rusts)}}$$

Losses are indicated as a trace when the disease is present but no fields are known to have suffered significant losses. If a few fields suffered measurable losses this is reflected as a percent of the state's production. Zeros indicate the disease was not reported in that state during the season.

Table 1. Physiological races of *Puccinia graminis* f. sp. *avenae* identified from oats in 1988.

State	Source of collection	Number of coll.	Number of isol.	Percent of isolates of each race[1] NA-5	NA-10	NA-12	NA-16	NA-25	NA-27	NA-32	BBB[2]
AR	Nursery	1	1						100		
CA	Nursery	3	9	67	33						
	Wild oats	2	6		100						
GA	Nursery	1	3						100		
KS	Nursery	3	8				13		88		
LA	Nursery	6	16				75		25		
MN	Field	10	30						100		
	Nursery	2	3						100		
	Wild oats	1	3						100		
ND	Nursery	2	6						100		
	Wild oats	3	9						100		
NE	Nursery	3	7						100		
OR	Nursery	1	3								100
SD	Nursery	1	3						100		
TX	Nursery	32	92				4		96		
WI	Field	12	31						100		
	Nursery	2	6						100		
	Wild oats	1	0								
WV	Field	4	9	44					33		22
USA	Field	26	70	6					91		3
	Nursery	57	157	4	2		11		82		2
	Wild oats	7	18		33				67		
	Total	90	245	4	4		7		83		2
CAN[3]	Field	3	9			100					
	Nursery	10	30			17		27	47	10	

[1] See Martens et al., Phytopathology 69:293-294.

[2] This race is avirulent on all oat stem rust differentials tested (i.e., Pg-1, Pg-2, Pg-3, Pg-4, Pg-8, Pg-9, Pg-13, Pg-15, Pg-16, Pg-a).

[3] All collections from Ontario.

Table 2. Estimated losses in oats due to rust in 1988.

OATS

State	1,000 of acres harvested	Yield in bushels per acre	Production in 1,000 of bushels	Losses due to Stem rust %	Losses due to Stem rust 1,000 bushels	Losses due to Crown rust %	Losses due to Crown rust 1,000 bushels
Alabama	20	55.0	1,100	0	0	Trace	Trace
Arkansas	35	90.0	3,150	0	0	Trace	Trace
California	35	70.0	2,450	1.0	25.0	1.0	25.0
Colorado	60	50.0	3,000	0	0	0	0
Georgia	45	63.0	2,835	0	0	Trace	Trace
Idaho	45	68.0	3,060	0	0	0	0
Illinois	180	51.0	9,180	0	0	0	0
Indiana	75	40.0	3,000	0	0	0	0
Iowa	550	48.0	26,400	0	0	Trace	Trace
Kansas	150	39.0	5,850	0	0	0	0
Kentucky	8	50.0	400	0	0	0	0
Michigan	200	30.0	6,000	0	0	0	0
Minnesota	750	33.0	24,750	Trace	Trace	Trace	Trace
Missouri	40	36.0	1,440	0	0	Trace	Trace
Montana	90	31.0	2,790	0	0	0	0
Nebraska	320	38.0	12,160	0	0	Trace	Trace
New York	145	52.0	7,540	0	0	Trace	Trace
North Carolina	55	65.0	3,575	0	0	Trace	Trace
North Dakota	400	18.0	7,200	0	0	Trace	Trace
Ohio	200	45.0	9,000	0	0	0	0
Oklahoma	65	45.0	2,925	0	0	0	0
Oregon	65	100.0	6,500	0	0	0	0
Pennsylvania	260	50.0	13,000	0	0	0	0
South Carolina	48	61.0	2,928	0	0	0	0
South Dakota	800	25.0	20,000	0	0	Trace	Trace
Texas	200	45.0	9,000	Trace	Trace	0	0
Utah	14	72.0	1,008	0	0	0	0
Virginia	12	53.0	636	0	0	Trace	Trace
Washington	37	67.0	2,479	0	0	0	0
West Virginia	6	48.0	288	Trace	Trace	0	0
Wisconsin	580	34.0	19,720	Trace	Trace	Trace	Trace
Wyoming	40	35.0	1,400	0	0	0	0
Total	5,530		214,764		25.0		25.0
Average		38.8		0.01		0.01	
U.S. total	5,590	39.1	218,773				

The University of Sydney

Plant Breeding Institute

Oat Rust Survey 1987-88

J.D. OATES
Plant Breeding Institute, Castle Hill.

Good conditions throughout the cereal belts of Australia and determined collecting by a number of co-operators achieved a reasonable response in most areas. Only in Victoria was there a disappointing result, in all other areas of Australia the response reflected the amount of inoculum present in the field.

234 samples were received, 53% were identified as being on wild oat species. 15 Samples failed to germinate.

Oat Stem Rust *Puccinia graminis* f.sp. *avenae*

Of 124 viable stem rust accessions, 199 isolates were identified. The International Races and Local Strains recovered during the 1987-88 Survey are listed in Table 1 which also lists their Virulence Pattern, Frequency and Area from which each was recovered.

The range of isolates recovered was consistant with that found in recent years. However, a small number of strains were recovered which combined virulence for the sand oat, Saia. Virulence for pg13 was found on a South Australian accession for the first time; a similar isolate was recovered for the first time in Australia from Western Australia in 1984-85. Race 14 with additional virulence for pg13 was found on 2 accessions from Aorangi, New Zealand. Generally, five races dominate the Survey (1,2,20,22 and 24). Race 20, particularly, continues to dominate the Queensland oat rust flora and race 2 dominates in South Australia.

Oat Leaf (Crown) Rust *Puccinia coronata* f.p. *avenae*

26 races of leaf rust were identified on the international set of differential varieties (Table 2); four races recovered in the previous survey were not identified in 1987-88 and five races were identified

for the first time, 3 from N.Z., 1 from N.S.W. and 1 from Queensland (* in Tables 2 and 3) .

From 110 viable accessions, 146 viable accessions were identified. Races 203, 216 and 226 were the common isolates; however, Race 203 joins 216 dominating Queensland, Race 240 was not recovered from Western Australia.

Table 3 lists the Frequency of each race and the area from which each was isolated through the Survey Period, April, 1987 and March, 1988.

By the use of the supplemental differential lines: Pc 38, 39, 45, 48, 50, 55, 56, Ascencao, TAM 301, TAM 312, Swan and Mortlock, a further 28 strains of the above races were identified, totaling 65 isolates (45% of all isolates). Line Pc 45 was susceptible to 38%, and Pc 38 to 5% of all isolates.

Only the lines Pc 38, Pc 45 and Pc 48 were found to be susceptible. In Table 4, the geographic spread of the virulent isolates on the supplemental differential lines and their frequency is illustrated. Clearly, Pc 45 as a single donor of resistance to oat leaf rust cannot be recommended, although in combination with Pc 38 Pc 48, it may have a place.

Table 1. Frequency and Distribution of Oat Stem Rust Races Identified During the 1987-88 Australasian Oat Rust Survey

Race	Virul Pg	Qld.	N.NSW	S.NSW	Vic	SA	WA	NZ	Total
1	-		4	7		17	2		30
2	3		8	19	1	32	2		62
2+Pg13	3,13					1		1	2
2+Saia	3,Sa			1					1
3	1		1						1
6	1,2,3		2	1					3
7	1,3			1					1
8	2,3	1	1						2
14+Pg13	4,13							2	2
18	1,2,4	3	2						5
20	1,2,3,4	11	4	8		1			24
20+Saia	1,2,3,4, Sa			1					1
22	2,3,4	1	5	12	1	6	5	1	31
22+ Saia	2,3,4 Sa		1	1					2
24	2.4	3	4	5		6	4		22
24+Saia	2,4 Sa							1	1
59	1,3,Sa			1					1
*59 + Pg9	1,3,9, Sa			1					1
61	1,3,8	1							1
Saia	Sa		1	4		1			6
		20	33	62	2	64	14	4	199

*59 + Pg 9 = 80 + Sa

Table 2. Oat Leaf Rust Races Identified During the 1987-88 Australasian Oat Rust Survey on a Standard International Set of Differential Varieties

Differential Variety*

Race	1	2	3	4	5	6	7	8	9	10	No Isolates
201	-	-	S	S	-	-	-	-	-	-	9
202	S	-	S	S	-	-	-	-	-	-	1
203	S	-	S	S	-	-	S	-	-	-	21
211	-	-	S	S	-	-	S	-	-	-	12
213*	S	S	S	S	-	-	-	-	-	-	1
216	S	S	S	S	-	-	S	-	-	-	27
226	S	-	S	-	-	-	S	-	-	-	29
227	S	-	S	-	-	-	S	-	-	S	2
230	-	-	S	-	-	-	S	-	-	-	11
231	S	-	-	-	-	-	S	-	-	-	1
236	S	-	S	-	-	-	-	-	-	S	2
237	S	-	S	-	-	-	-	-	-	-	4
241	S	-	S	S	-	-	S	-	-	S	1
255	S	-	S	-	-	-	-	S	-	S	1
272	-	-	S	-	-	-	S	-	-	S	1
274*	-	S	S	S	-	-	S	-	-	-	3
275	-	-	S	S	-	-	S	-	-	S	1
276	S	-	S	S	S	S	S	S	S	-	3
279*	-	S	S	S	-	-	-	-	-	-	1
283*	-	S	S	-	-	-	-	-	-	-	1
294	-	-	S	S	S	S	S	-	-	-	2
295	S	-	S	S	S	S	S	-	-	-	7
296*	-	-	-	S	-	-	-	-	-	S	1
384	-	-	S	S	S	S	S	S	S	-	2
416	-	-	S	-	S	S	S	-	-	-	1
427	S	-	S	-	S	S	S	-	-	-	1
											146

* 1 Anthony, 2 Victoria, 3 Appler, 4 Bond, 5 Landhafer, 6 Santa Fe, 7 Ukraine, 8 Trispernia, 9 Bondvic, 10 Saia

Table 3. Frequency and Distribution of Oat Leaf Rust Strains Identified During the 1987-88 Australasian Oat Rust Survey

Race	Qld	N.NSW	S.NSW	Vic	SA	WA	NZ	CH	Total
201		2					7		9
202					1				1
203	11	8			2				21
211	6	5					1		12
213*							1		1
216	10	11			4	1	1		27
226		3	4	2	10	8		2	29
227			1		1				2
230	1	3	2		1	3		1	11
231						1			1
236					1	1			2
237					2	2			4
241		1							1
255		1							1
272						1			1
274*							3		3
275	1								1
276	2		1						3
279*							1		1
283*								1	1
294	2								2
295	3	2			2				7
296*	1								1
384	2								2
416		1							1
427			1						1
	39	37	9	2	24	17	14	4	146

Table 4. Frequency and Distribution of Isolates Virulent on Differential Lines used in the 1987-88 Australasian Oat Rust Survey

Lines	Qld	N.NSW	S.NSW	Vic	SA	WA	NZ	Total
Pc 38	2				1	1		4
Pc 45	13	17	6	2	7	7	1	53
Pc 48	1					1		2
Pc 38,45			1			2		3
Pc 45,48			1		2			3
	16	17	8	2	10	11	1	65

RESISTANCE OF SOME NEW YUGOSLAV SPRING OAT LINES TO PUCCINIA CORONATA, PUCCINIA GRAMINIS AVENAE and ERYSIPHE GRAMINIS AVENAE IN 1988

Ponos Branka, Miodrag Krstic and Maksimovic Dragoljub

Crown rust, stem rust and powdery mildew are three of the most frequent oat diseases in Yugoslavia. Investigation of resistance to these pathogens was performed in the oat growing area with more than forty spring oat lines created in Institute for Small Grains in Kragujevac. The study included estimating naturally infected adult plant resistance to *Puccinia coronata*, *Puccinia graminis avenae* and *Erysiphe graminis avenae*. Some results are given in Table 1.

Table 1. Reaction of some spring oat lines to natural infection of *Puccinia coronata*, *Puccinia graminis avenae* and *Erysiphe graminis avenae*.

		Crown rust		Stem rust		Powdery mildew	
No.	Line	a	b	a	b	a	b
1	2	3	4	5	6	7	8
1.	L - 6/18	4	10	4	10	0	0
2.	L - 18/20	4	10	0	0	0	0
3.	L - 1/15	4	10	0	0	1	10
4.	L - 2/2	4	10	0	0	0	0
5.	L - 2/3	4	10	4	5	1	t
6.	L - 5/13	4	5	4	5	0	0
7.	L = 6/21	3	20	0	0	1	5
8.	L - 8/46	4	5	4	5	0	0
9.	L - 8/43	4	5	0	0	1	t
10.	L - 8/48	4	5	0	0	3	5
11.	L - 9/8	4	5	4	10	0	0
12.	L - 9/24	4	10	0	0	4	t
13.	L - 9/27	4	5	4	5	2	t
14.	L - 2/9	4	10	4	5	2	5
15.	L - 2/13	4	15	0	0	1	t
16.	L - 7/9	4	5	0	0	3	t
17.	L - 8/5	4	5	3	5	1	10
18.	L - 1/17	4	5	4	5	1	10
19.	L - 1/9	4	5	4	10	2	10
20.	Condor	3	10	0	0	0	0

a = infection type
b = severity

Resistance to stem rust and powdery mildew was satisfactory on conditions of natural infection, but resistance to crown rust was not. No variety reacted with a resistant infection type but there were a few with low severity.

There is a need for further work in breeding for resistance to crown rust and it is considered as another task in selection of new spring oat cultivars in the Institute for Small Grains.

SCREENING FOR PARTIAL RESISTANCE TO ERYSIPHE GRAMINIS DC. F.SP. AVENAE MARCH. OF AVENA WILD SPECIES

Heinz-Dieter Hoppe and Manfred Kummer

186 samples of 22 *Avena* wild species (Table 1), which had been cultivated under plastic house conditions, were evaluated with regard to partial resistance to powdery mildew (*Erysiphe graminis* DC. f.sp. *avenae* March.). The screening experiments were carried out during 1986-88. Twenty-four to 48 plants of each sample were screened, as a rule (exceptions see Table 2). Powdery mildew epidemics developed from natural inoculum. The first colonies were detected at the booting stage. Reaction on mildew-infection was assessed according to a 9 - 1 scale with 1 symbolizing maximum susceptibility. The number of scorings made during the season in the different years is shown in Table 2. The partial resistance was characterized by the area under the disease progress curve. The resistant samples are compiled in Table 2.

Table 1. *Avena* species and the number of samples screened for partial resistance to powdery mildew.

Species	Ploidy level	Number of samples
A. clauda	diploid	4
A. pilosa	"	7
A. prostrata	"	1
A. longiglumis	"	5
A. damascena	"	3
A. canariensis	"	8
A. wiestii	"	3
A. ventricosa	"	4
A. hirtula	"	13
A. strigosa	"	21
A. atlantica	"	12
A. barbata	tetraploid	13
A. vaviloviana	"	4
A. abyssinica	"	10
A. murphyi	"	1
A. magna	"	4
A. agadriana	"	16
A. macrostachya	"	1
A. fatua	hexaploid	9
A. sterilis	"	16
A. byzantina	"	9
A. hybrida	"	22

Table 2. Powdery mildew resistant samples of different Avena wild species characterized by the area under the disease progress curve.

Cultivars resp. species	1986[1]	1987[1]	1988[2]
Susceptible standards:			
Solidor	110	206.5	59.5
Milford	80	305	44.5
A. pilosa CAV 0128	396[3]	387[3]	270[3]
A. prostrata CAV 5263	254	383.5	251
A. longiglumis Qu 8	344	350.5	129.5
A. ventricosa VIR 21	271.5	-	-
VIR 213	325.5	-	-
A. hirtula VIR 154	292	-	152
CAV 2390	-	311[4]	183
A. strigosa Cc 3678	-	376	255
Qu 14	337	354.5	213.5
Qu 16	296.5	-	138
Qu 180	315	-	-
A. atlantica CAV 6794	-	358[4]	243.5
A. murphyi CAV 2832	281.5	-	197.5
A. macrostachya CAV 5264			
(field nursery)	396[3]	387[3]	270[3]
A. agadriana CAV 6770	-	332.5[4]	251

[1] Seven scorings during the season.
[2] Five scorings during the season.
[3] No infection symptoms.
[4] Only five plants for screening, because of shortage of seeds.
VIR Avena collection of N.I. Vivilov All Unions Scientific Research Institute of Plant Industry Leningrad, USSR.
Qu Avena collection of Institute of Breeding Research Quedlinburg, GDR.

RESISTANCE IN OAT ENTRIES TO TWO APHID SPECIES (Hom. Aphididae)*

Claud Goellner and Elio Corseuil

INTRODUCTION

Aphids, mainly the species *Metopolophium dirhodum* (Walker) *Schizaphis graminum* (Rondani) and *Sitobion avenae* (Fabricius), are the main insect pest problem on oats. Yield loss is estimated at 35%, and 60-65% when including damage by Barley Yellow Dwarf Virus (BYDV) (Goellner et al., 1982).

WILSON et al. (1978) studied the resistance in four oat lines to two biotypes of the greenbug *Schizaphis graminum* in greenhouse conditions. The results showed PI 186270 had antibiosis, nonpreference, and tolerance to biotype C, the biotype predominant in the Great Plains. CI 4888 had antibiosis, nonpreference, and tolerance to biotype B. CI 1579 and 1580 showed antibiosis to biotypes B and C and nonpreference to biotype C.

The increasing complexity of insect pest control has emphasized the need for more effective control measures and the use of resistant varieties is one promising possibility. Screening for resistance, and incorporating it in varieties with other desirable agronomic characteristics is very important for oat development in Brazil. The goal of this research was identification of the resistant sources in local and introduced collections, to yellow aphid *Metopolophium dirhodum* and the greenbug *Schizaphis graminum*.

MATERIAL AND METHODS

Thirty-four selections were tested in insectary conditions for tolerance to the yellow aphid *Metopolophium dirhodum* and the greenbug *Schizaphis graminum*. The tests to two species were performed separately with four replicates in a randomized design.

Three plants of each line were planted in small pots and infested with fifty virus free aphids per plant at the one leaf stage during a 10-day period. The evaluations that were done include the damage rating by using a scale ranging from 1= no damage to 5= dead or dying plant, percent of normal growth calculated by comparing the amount of plant growth with aphids to the plants receiving no aphids and the percent of dry matter reduction by the same criteria.

---

*Research done as a component of M.Sc. Dissertation in Agriculture (Plant Science) at Agricultural School of Federal University of Rio Grande do Sul, Brazil.

Data were summarized in the General Index of Resistance (GIR) by the formula as follow.

$$GIR = \frac{(PDMR \times 0.3)+(PNGR \times 0.1)}{20} + (DR.0.6)$$

GIR = General Index of Resistance
PDMR = Percent of Dry Matter Reduction
PNGR= Percent of Normal Growth Reduction
DR = Damage Rating (Chlorosis)

Analysis of variance and Duncan's Multiple Range Test were calculated for the General Index of Resistance to the two species.

RESULTS AND DISCUSSION

Table 1 summarizes data for 34 oat entries tested for tolerance to _S. graminum_ and _M. dirhodum_.

Table 1 - Tolerance of 34 oat entries to two species of aphids. Passo Fundo, Brazil. 1984.

UPF 79229-1-7	2.6 c	MR	3.8 ab	S
UPF 77256-5	1.1 fg	RR	4.4 a	S
UPF 79344	2.0 de	R	4.4 a	S
UFRGS 79A65	2.4 cd	R	4.4 a	S
UPF 79176-1-9	2.9 bc	MR	3.6 c	S
UFRGS 79A07	1.2 f	RR	4.5 a	SS
UPF 77256-5-5b	3.4 ab	MR	3.9 ab	S
UPF 77258-2-1-5b	2.2 cd	R	4.3 a	S
UPF 79B347	2.5 c	MR	3.9 a	S
UPF 77101-1	1.1 fg	RR	3.6 bc	S
UPF 78S212	1.2 f	RR	3.7 bc	S
UFRGS 78A04	3.7 a	S	3.7 bc	S
UPF 77S030	1.0 fg	RR	3.2 d	MR
UPF 77S030-1	3.8 a	S	2.8 d	MR
UFRGS 81A03	1.7 e	R	3.0 d	MR
UPF 80S084	1.3 ef	RR	2.9 d	MR
UPF 77258-5-1b	2.2 cd	R	4.1 a	S
UPF-2	3.8 ab	MR	4.5 a	SS
UPF 79294-1	4.1 a	S	3.9 ab	S
CTC 78B207	1.1 fg	RR	4.0 a	S
UPF 80S071	1.5 e	RR	4.0 a	S
UPF 79I176-4	2.6 c	MR	4.1 a	S
UFRGS 79A20	2.3 cd	R	4.4.a	S
UPF 79176-1-8	1.7 e	R	3.8 b	MR
UPF 77104-1	1.3 ef	RR	4.5 a	SS
UPF 80S099	2.9 b	MR	4.3 a	S
CTC 78F10	2.6 c	MR	4.5 a	SS
UPF 80S097	2.3 cd	R	2.6 d	MR
CI 7512	1.3 ef	RR	2.9 d	MR
UPF 77258-5	1.6 e	R	3.3 d	MR

Table 1 (continued)

OAT ENTRY	S. graminum		M. dirhodum	
	GIR*	Resistance	GIR*	Resistance
UPF 79I176-4	2.6 c	MR	4.1 a	S
UFRGS 79A20	2.3 cd	R	4.4.a	S
UPF 79176-1-8	1.7 e	R	3.8 b	MR
UPF 77104-1	1.3 ef	RR	4.5 a	SS
UPF 80S099	2.9 b	MR	4.3 a	S
CTC 78F10	2.6 c	MR	4.5 a	SS
UPF 80S097	2.3 cd	R	2.6 d	MR
CI 7512	1.3 ef	RR	2.9 d	MR
UPF 77258-5	1.6 e	R	3.3 d	MR
UFRGS 82A12	0.9 g	RR	4.0 a	S
UPF 77286-4	2.6 c	MR	2.9 d	MR
CORONADO	2.9 bc	MR	2.8 d	MR
UPF 77256-14-1b	3.1 b	MR	4.1 a	S

* Means followed by the same letter are not significantly different to P 0.05.

Tolerance to S. graminum was more abundant in local entries that have resistance genes of American introductions which have been used in a plant breeding program at Passo Fundo University. UPF 80S071, UFRGS 79A07, CTC 78B207, UPF 77104-1, CI 7512 were highly resistant to greenbug.

Resistance to yellow aphid was more rare and some lines were moderately resistant such as UPF 77S030, UPF 79176-18, UPF 79286-4, CORONADO and CI 7512. CI 7512, an american introduction, was highly resistant to greenbug and moderately resistant to yellow aphid.

REFERENCES CITED

GOELLNER, C.I., FLOSS, E.L., EICHLER, L. & SCHENEIDER, S. 1983. Breeding for Aphid Resistance in Oats. Oat Newsletter. 33:14-16.

WILSON, R.L., STARKS, K.J., PASS, H. & WOOD, E.A. 1978. Resistance in four oat lines to two biotypes of the greenbug. Journal of Economic Entomology, Baltimore, 71:886-887.

EVALUATION OF SMALL GRAIN GERMPLASM
1988 PROGRESS REPORT

L. W. Briggle
Plant Sciences Institute
Beltsville Agricultural Research Center

Systematic evaluation of accessions in the USDA-ARS National Small Grains Collection (NSGC) was initiated in 1983. The entire Collection was moved from Beltsville, MD, to Aberdeen, ID, in the fall of 1988. Evaluations conducted during FY 1989 and thereafter will be directed by Dr. D. M. Wesenberg from the new Small Grain Germplasm Research Facility located at Aberdeen, ID.

A set of descriptors appropriate for each of the principal small grain crop species - wheat, barley, oats, and rice - was established in collaboration with the appropriate Crop Advisory Committees (CAC's) prior to 1983. A few minor changes have been made since that time.

Data on field descriptors have been obtained on approximately 33,000 wheat accessions, 11,000 oat accessions, and 9,000 barley accessions during the 1983-88 period. Special nurseries were grown for that purpose at Aberdeen, ID, and at Mesa or Maricopa, AZ. Grain was harvested from each field evaluation nursery to replenish seed stocks at Beltsville (and now Aberdeen) for distribution to research personnel, both domestic and foreign.

Field evaluation data were recorded on such descriptors as number of days from planting to anthesis (heading), plant height, spike (or panicle) type, spike (or panicle) density, straw lodging, straw breakage, seed shattering, and awn and glume characteristics, including color.

Spikes or panicles were collected from each evaluation or nursery plot at maturity to facilitate detailed laboratory analysis for seed characters and for more precise spike or panicle descriptors than can be obtained under field conditions.

Weight of grain harvested from each evaluation plot was recorded. That grain will be used for further evaluation (for disease and insect resistance, quality factors, etc.) in addition to distribution as referred to above.

Duplicate oat and wheat accessions (named varieties that appear two or more times in the NSGC) have been grown and studied for identification at Aberdeen, ID. True duplicates were bulked and that "new" seed lot will be carried under the lowest CI or PI number involved in the bulk.

Evaluation for disease and insect resistance was initiated in 1983 and expanded each year since. Accessions evaluated so far are as follows:

Barley Yellow Dwarf Virus	1983-88	<u>Davis, CA</u> 15,000 wheats 7,000 barleys 4,500 oats	<u>Urbana, IL</u> 15,000 wheats 10,000 oats
Soilborne Mosaic Virus:	1985-88	<u>Urbana, IL</u> 10,000 wheats	

Hessian Fly:	1983-88	Lafayette, IN 24,000 wheats	
Crown Rust:	1983-85	Ames, IA 9,250 oats	
	1986	2,000 *Avena sterilis*	
Leaf Rust:	1983-88	Manhattan, KS 28,000 wheats	
Spot Blotch	1985-88	Fargo, ND 9,000 barleys	Athens, GA 2,200 barleys
Net Blotch	1985-88	Fargo, ND 7,000 barleys	Athens, GA 2,200 barleys
Barley Stripe Mosaic Virus	1986-88	Aberdeen, ID 8,700 barleys	
Common and Dwarf Bunt	1985-86	Pendleton, OR 5,000 wheats	
Stripe Rust:	1984-88	Pullman, WA 21,500 wheats	
Stem Rust:	1987-88	St. Paul, MN 4,700 wheats 184 Aegilops	Fargo, ND 290 Aegilops
Karnal Bunt	1988	Ludhiana, India 503 wheats	

Growth habit (winter, facultative, or spring type) determinations originally were done at Bozeman, Montana from a late spring planting made in June. Data were also recorded on field evaluation plots at Aberdeen, Idaho and Maricopa, Arizona when growth habit was apparent. In 1987 the growth habit evaluation nursery was shifted to Aberdeen, ID. Approximately 21,600 wheats, 3,400 oats, and 5,000 barleys have been tested for growth habit to date.

Many wheat accessions and some *Triticum* species in the NSGC are misclassified. Some misclassification occurs in the oats and Avena species, but to a lesser extent. The problem is minor in the barleys and *Hordeum* species, but all accessions need to be carefully checked. This is done at the time an accession is grown in any evaluation nursery.

Mixtures occur in some accessions in all NSGC crop species. Some accessions were actually heterogeneous populations when obtained, and will be retained as populations. Where appropriate, accessions are rogued and every effort made to clean them up, including establishment of special "Purity Nurseries" at Aberdeen, Idaho and Maricopa, Arizona. Those which cannot readily be rogued are grown in thinly planted 2-row plots bordered by another species. Spaced plants facilitate selection of only the original type plants.

An extremely valuable part of the National Small Grain Collection is that of the related species. For example, some 700 accessions of *Aegilops* species make up part of the wheat collection. There is a real need for taxonomic expertise so that all new introductions can be correctly classified upon entry into the NSGC. By far most of our current botanical classification problems could have been averted if there had been appropriate taxonomic input from the beginning. We do use ploidy analysis where possible, but that is expensive and time-consuming. Since 1983, 775 ploidy analyses hae been obtained. Most were used to differentiate between *Triticum aestivum* and *T. durum* when morphological characters overlapped. The need for taxonomic input as an integral part of the NSGC program cannot be overemphasized.

PI Number Assignment National Small Grain Collection 1988-89

George A. White, Mark A. Bohning, L.W. Briggle, and D.M. Wesenberg
USDA-ARS, Beltsville, Maryland and Aberdeen, Idaho

The following PI numbers were assigned in 1988-89. Please note that assignment of a PI number does not guarantee immediate availability.

PI Number	Genus	Species	Country of Origin	Cultivar Name
516506	Avena	bromoides	Morocco	
516507	Avena	bromoides	Morocco	
518513	Avena	nuda	United States	Pennuda
515922	Avena	sativa	United States	
515923	Avena	sativa	United States	
515924	Avena	sativa	United States	
515925	Avena	sativa	United States	
515926	Avena	sativa	United States	
515927	Avena	sativa	United States	
515928	Avena	sativa	United States	
515929	Avena	sativa	United States	
515930	Avena	sativa	United States	
515931	Avena	sativa	United States	
515932	Avena	sativa	United States	
515933	Avena	sativa	United States	
515934	Avena	sativa	United States	
515935	Avena	sativa	United States	
515936	Avena	sativa	United States	
515937	Avena	sativa	United States	
515938	Avena	sativa	United States	
515939	Avena	sativa	United States	
515940	Avena	sativa	United States	
515941	Avena	sativa	United States	
515942	Avena	sativa	United States	
515943	Avena	sativa	United States	
515944	Avena	sativa	United States	
515945	Avena	sativa	United States	
515946	Avena	sativa	United States	
515947	Avena	sativa	United States	
518512	Avena	sativa	United States	
524422	Avena	sativa	United States	Delredsa
524423	Avena	sativa	United States	Obee
524424	Avena	sativa	United States	Aojss
525183	Avena	sativa	United States	Valley

THE AUSTRALIAN WINTER CEREALS COLLECTION

M. C. MacKay, Curator

Establishment of the national oat collection has proceeded according to plan so far. There will be a delay of one year in processing the 'unnamed' oat material provided by Australian breeders due to a backlog in drying and sealing accessions for long term storage.

All data held on oat accessions is computerized and a 'genebank manager' software package has been developed to manage all information relating to requests for seed, ordering of seed from other countries, quarantine, dispatch to users, preparation of field books and production of a newsletter advising users of recent introductions. The 'genebank manager' also updates master database files after descriptive and evaluation data has been collected from field plantings.

The oat collection is available for use by all oat researchers. We are particularly keen to exchange germplasm with other institutions. Listings of this collection can be made available for this purpose now, however, it is hoped microfiche listings will be generally available by mid 1990.

OAT CULTIVARS REGISTERED IN 1988

Aus No.	NAME	PEDIGREE	STATE RELEASED
701272	CLUAN	Shaw/Ogle	Tasmania
701276	QUAMBY	OT521/RL 3060	Tasmania
701274	HAY	OT207/Swan	Western Australia
701273	DALYUP	OT207/Swan//Moregrain/West	Western Australia
701275	KALGAN	OT207/Swan	Western Australia
701291	YARRAN	M127/Radar 2//M1345/3/TAMO-312	New South Wales

DEVELOPMENT OF IDEAL PLANT TYPE IN RELATION TO FODDER YIELD IN OAT (AVENA SATIVA L.)

D. S. Katiyar and U. S. Mishra

The ideotype concept in grain crops (Donald 1968) provided a physiological basis for breeding programs. Such knowledge is not available in case of fodder crops. A fodder ideotype must meet dual requirements, i.e. fodder and seed yields.

In order to work out an ideal plant type, a study of recombination of various fodder contributing and seed yield characters was undertaken. In the study six crosses (Kent X Flemings Gold, Kent X EC 17887, Kent X 11251-9, Kent X NP 101, Kent X Early Miller and EC 17887 x NP101) were attempted. F_1 hybrids along with parents were raised to study fodder attributes and seed yield. Parental combinations manifesting heterosis for fodder characters were identified.

In the F_2 generation these crosses were grown along with parents in a replicated trial. The material was grown by sowing seeds 10 cm apart in 3 m rows spaced 30 cm apart. Data on growth parameters viz. plant height, leaf number, leaf length, leaf width, leaf inclination, stem girth, tiller number and leafiness were recorded at 50% flowering. Plants combining desirable expression of these characters were selected.

In the F_3 generation selected plants were again grown in replicated rows by drilling the seeds in 3 m long rows spaced 30 cm apart. Similar observations were recorded and several desirable plants were isolated.

In the F_4 generation selected progenies of the six crosses listed above were planted in replicated rows by drilling the seeds in 3 m rows spaced 30 cm apart. Besides the study on fodder yield contributing parameters, a detailed study on leaf inclination and physiomorphic characters was also undertaken. Three plant types, namely erect, dropping and spreading, were visually recognized. The erect and spreading types possessed stiff erect short leaves while drooping types had long droopy leaves.

The interrelationships of physiomorphic characters such as leaf area index, stomata frequency, specific leaf weight, net assimilation rate, plant height, and tiller number with fodder yield at 50% flowering were studied. Intrinsic differences among the three types in respect of physiological characters contributing to fodder yield were observed. Drooping plant types were found to be superior in fodder yields.

EVALUATION OF NEW OAT STRAINS FOR FORAGE ATTRIBUTES

S. N. Mishra and J. S. Verma

Oats are harvested for forage production in the northern states of India where at least 4 to 5 months of winter season prevail. It is the only cereal fodder available during winter months which is utilized either with the forage legumes like berseem clover and lucerne or with wheat straw. In the oat improvement program the objective of higher green and dry matter yield remains one of the most important aspects. After preliminary small scale trials, the most important selections are tested for forage yield potential in larger trials and then entered for testing at the national level over many locations and years. The present study reports the performance of such advanced selections with respect to certain important attributes in the preliminary trial.

During the winter 1987-88, we evaluated 28 new strains along with the check varieties 'UPO 94' and 'Kent' for plant height, days to 50% heading, green forage yield (GFY) and dry matter yield (DMY). The trial was conducted in a randomized complete block design with two replications. The plot size was 4.5 square meter. The study indicated that ten strains had better forage producing ability than both the checks (Table 1). The highest GFY was obtained from OX 342-4-3-2-5 with 62.8 t/ha. This strain also produced 11.3 tons of DMY per hectare. Other high performing strains were OX 364-2-3-1-2, OX 364-2-3-1-3, OX 364-2-3-1-5, OX 342-2-2-1-2 and OX 342-3-2-1-2 giving above 50 t/ha of GFY and 7 to 10 t/ha of DMY. The high performing strains are the materials derived from crosses between Lang x Swan and Orbit x Swan. Lang and Orbit are of US origin and Swan was introduced from Australia. These diverse two parent crosses performed better than other crosses. The other promising strain (OX 372-2-2-1-3) is again derived from a cross involving (Bingham x Swan) x (Coolabah x Swan) producing 58.9 t/ha of GFY and 10.8 t/ha of DMY. Again Bingham being of US origin and Coolabah and Swan of Australian origin. Strain OX 254-1-5-2-1 which gave 53.3 t/ha of GFY and 10.1 t/ha of DMY was the progeny of a backcross (4628 x Indio) x 4628. Some of the strains having *Avena sterilis* genes (strains 1 to 5) did not perform well when crossed with Spear (strains 1 to 4) and Bingham (strain 5). These strains were shorter in height and had thin culms as compared to others and these may have been the reasons for low green forage and dry matter yields.

This study provides information relative to the type of parents which should be used in deriving high performing strains in forage production. Some of the high performing strains will now be tested in the national varietal trial over locations and years.

Table 1. Mean performance of new oat strains for forage attributes.

Sl No.	Pedigree	Plant height (cm)	Days to 50% heading	GFY (t/ha)	DMY (t/ha)
1.	OX453-5-3-1	103.0	102.0	36.7	6.3
2.	-5-3-2	107.5	102.5	36.7	6.1
3.	-5-3-3	102.5	102.0	33.3	5.7
4.	-5-5-2	128.0	115.5	41.7	8.3
5.	OX557-3-1-2-2	134.5	102.5	42.8	8.4
6.	OX345-1-1-2-5	115.0	117.0	40.0	7.8
7.	-1-1-2-2	114.0	118.0	29.4	6.3
8.	OX364-2-2-1-2	135.0	104.0	35.6	7.1
9.	-2-3-1-2	137.5	105.5	51.1	7.4
10.	-2-3-1-3	147.5	106.5	55.0	10.2
11.	-2-3-1-5	140.5	105.0	54.5	8.7
12.	OX342-2-2-1-2	132.5	107.0	55.6	9.6
13.	-3-2-1-2	142.5	107.5	53.3	8.9
14.	-4-3-2-5	147.5	105.0	62.8	11.3
15.	OX343-1-1-2-4	83.0	104.5	40.6	7.3
16.	OX372-2-2-1-3	132.5	118.5	58.9	10.8
17.	OX371-1-1-3-1	141.0	104.5	47.2	7.1
18.	OX373-6-3-2-1	115.0	103.5	40.6	6.3
19.	OX308-1-2-1-2	132.5	102.0	45.6	7.3
20.	OX313-14-3-1-2	125.0	106.5	46.1	9.3
21.	OX328-21-2-1-2	136.0	105.0	39.4	5.9
22.	OX332-7-37-1-1	130.0	104.0	37.2	5.6
23.	OX293-11-1-2-2	115.5	111.5	32.8	6.4
24.	OX246-16-1-2-3	141.5	116.0	43.9	9.1
25.	-16-3-1-2	132.5	116.5	32.2	6.2
26.	-16-3-1-1	132.5	117.5	37.2	7.4
27.	OX117-35-1-2-2	142.0	103.5	42.2	7.8
28.	OX254-1-5-2-1	141.0	106.0	53.3	10.1
29.	UPO (check)	126.5	116.0	45.6	8.9
30.	Kent (check)	131.0	105.5	43.3	8.6
	General mean	128.2	108.0	43.8	7.8
	SEm ±	7.8	1.1	2.0	0.5
	C.D. (5%)	22.6	3.2	13.1	3.0

PERFORMANCE OF NEWLY BRED STRAINS OF OAT AT PANTNAGAR, INDIA

S. N. Mishra and J. S. Verma

Improved green and dry matter yields are still the most important objectives of oats improvement in the Indian conditions. However, the cultivars should also have an appreciable yield of grain for a satisfactory seed production program and for feed purposes. Before the strains are put in large trials for yield (green/dry) they are evaluated for grain yield potential. The present study was undertaken to assess the performance of some newly bred oat strains which have variable seed producing ability.

Performance of twenty-seven newly bred strains with respect to days to 50% heading, days to maturity, plant height at maturity, panicle length, number of spikelets per panicle and grain yield per plant is reported (Table 1). Out of these seven cross combinations from which the 27 strains were derived, 4 were two-parent crosses of diverse origin (OX 117 = Kent x Flamingold, OX 229 = Mugga x Montezuma, OX 238 = Forward x Indio and OX 246 = Sierra x Rapida), 1 was a backcross (OX 254 = (4628 x Indio) x 4628), and 2 were three-parent crosses (OX 261 = (Appler x Portal) x Montezuma), and OX 263 = (Portal x Bingham) x Kent). Different numbers of strains within each cross were selected to make twenty-seven.

There appeared to be differences within and between strains of the same and different cross combinations. None of the strains of OX 117 exceeded the general mean $\pm$ SEm. Among the single crosses OX 246 had two strains producing 36.0 and 34.0 g of grain yield/plant. Two other strains, one each of the crosses OX 229 and OX 238 produced 29.0 and 31.0 g grain yield/plant, respectively. Strains of crosses OX 254 and OX 261 had low grain yielding ability. Tbe most important cross appeared to be OX 263 in which 5 strains produced high grain yield over 29.0 g, the maximum being 40.0 g of OX 263-25-2-1-3. In this cross it may be important to point out that it contained 'Kent' as one of the parents which has plump kernels and is well adapted to Indian conditions. With respect to other characters, the strains again showed differences between and within crosses.

In general the selection criteria in early generations were resistance to crown rust, leaf blight and smut diseases. The observations indicated that triple crosses were better than the two-parent crosses. Among triple crosses, the one having an adapted parent did better than the one having all unadapted parents. These selected strains are being evaluated for their potential in single and multiple cut regimes for green and dry fodder yields.

Table 1. Performance of newly bred strains of oat at Pantnagar, India.

Sl No.	Pedigree	Days to 50% heading	Days to maturity	Plant height at maturity (cm)	Panicle length (cm)	Number of spikelets/ panicle	Grain yield/ plant (g)
1.	OX 117-6-4-1-2	104	132	139.9	32.0	87.0	18.0
2.	-35-2-1-2	104	128	171.8	36.0	67.4	27.0
3.	-35-2-1-3	102	127	170.2	35.7	67.0	24.0
4.	OX 229-2-1-2-3	106	132	158.6	28.3	55.4	29.0
5.	OX 238-5-3-2-1	105	132	129.4	26.8	108.5	26.0
6.	-5-3-2-2	105	133	119.9	26.8	111.2	31.0
7.	OX 246-1-2-2-2	106	132	135.6	25.9	61.4	36.0
8.	-4-2-1-1	107	136	150.7	31.3	68.0	25.0
9.	-4-2-1-3	105	135	149.0	30.8	74.0	27.0
10.	-5-2-2-2	103	130	148.5	26.5	94.5	19.0
11.	-10-3-2-1	102	129	140.0	24.3	107.2	23.0
12.	-16-3-1-1	116	142	144.8	28.1	98.9	34.0
13.	-16-3-1-2	114	140	164.0	26.7	94.4	21.5
14.	-16-1-2-3	112	139	176.2	27.6	99.8	21.9
15.	-27-2-2-2	108	137	158.2	29.5	77.1	19.5
16.	OX 254-1-5-1-2	109	138	163.5	28.5	83.5	16.5
17.	OX 261-27-1-2-1	104	130	172.0	32.2	78.9	23.8
18.	-27-1-2-2	102	129	174.9	31.6	87.5	19.0
19.	OX 263-7-3-1-1	116	141	195.7	45.7	103.8	23.0
20.	-7-3-1-2	114	143	177.7	41.8	93.0	18.0
21.	-7-3-1-3	113	140	166.9	38.8	104.2	28.0
22.	-10-1-2-1	103	145	159.1	34.1	87.6	29.0
23.	-10-1-2-2	105	136	169.9	36.2	101.1	31.0
24.	-25-2-1-1	109	142	164.7	39.8	113.5	32.2
25.	-25-2-1-2	110	146	165.7	40.7	115.7	38.0
26.	-25-2-1-3	112	144	175.5	41.2	103.8	40.0
27.	-17-2-2-3	118	138	159.8	32.3	99.9	19.0
	General mean	107.92	136.14	159.34	32.56	90.53	25.90
	Range	102-118	127-146	119.9-195.7	24.3-45.7	55.4-115.7	16.5-40.0
	SEm $\pm$	0.92	1.07	3.19	1.09	3.20	1.22
	C.D. 5%	2.67	3.11	9.27	3.11	9.30	3.54

PERFORMANCE OF OAT GENETIC STOCKS FOR SOME ECONOMIC TRAITS

D. S. Jatasra, B. S. Jhorar and C. Kishor

Existence of wide genetic variability in any species is the basic requirement for the development of improved varieties. Evaluation and cataloging of germplasm lines for various attributes help breeders in exploitation of genetic diversity in breeding programs aimed at evolving varieties for different uses. Accordingly, the present investigation was undertaken to evaluate the available genetic stock of oats, an important winter cereal fodder of Northern India, for some economic traits.

The breeding material comprised of 380 genotypes of fodder oat germplasm of indigenous and exotic origin maintained at Haryana Agricultural University, Hisar. All these lines were sown in 3m double-row plots with 30 cm row spacing at the University Research Farm, Hisar on Dec. 14, 1984 in an augmented design. Data were recorded for green fodder yield per plant (g), plant height (cm), the number of tillers per plant and the number of leaves per plant at 50 percent flowering stage.

The performance of the top 16 genotypes selected from 380 germplasm lines along with two check varieties of oats is presented rankwise in Table 1. HFO 397 followed by HFO 489 and HFO 15 produced the maximum green fodder yield (603.0 g/plant). Genotypes HFO 409, HFO 54, HFO 139 and HFO 55 produced much higher green fodder yields than the check varieties OS 7 and HFO 114. HFO 313 was the tallest line. Other tall varieties are listed in the table. For the number of tillers per plant, another important component of fodder yield, HFO 250 with average tiller number of 29.2 per plant, ranked first. Of the other promising genotypes for this trait, HFO 471, HFO 286, and HFO 421 were among the top-ranking lines. The number of leaves per plant is not only an important fodder yield contributing character but leafiness is also desirable for palatability and quality of forage in oats. HFO 471 had the maximum number of leaves and ranked second for tillering. Other genotypes superior for more than one attribute were HFO 489, HFO 89, HFO 250, HFO 78, and HFO 416. These genotypes identified as superior for different characters are being utilized in oat breeding programs at this university.

Table 1. Performance of the top sixteen oat germplasm lines for some economic traits.

	Green fodder yield (g/plant)		Plant height (cm)		Number of tillers per plant		Number of leaves per plant	
Rank	Genotype	Performance	Genotype	Performance	Genotype	Performance	Genotype	Performance
1	HFO 397	603.0	HFO 313	105.4	HFO 250	29.2	HFO 471	173.6
2	" 489	589.0	" 59	97.4	" 471	28.0	" 250	160.6
3	" 15	565.0	" 253	97.4	" 286	28.0	" 458	144.2
4	" 409	509.0	" 288	96.6	" 421	28.0	" 485	135.8
5	" 54	494.0	" 147	96.6	" 393	26.0	" 235	123.1
6	" 139	477.0	" 125	95.6	" 235	22.8	" 388	120.0
7	" 55	467.0	" 54	95.4	" 417	22.0	" 282	117.5
8	" 312	407.0	" 85	95.2	" 15	21.2	" 89	116.5
9	" 77	401.0	" 151	95.0	" 458	21.2	" 386	116.4
10	" 377	397.0	" 57	94.4	" 89	20.8	" 462	113.1
11	" 191	375.0	" 328	93.6	" 72	20.5	" 286	114.0
12	" 89	369.0	" 33	93.0	" 397	20.2	" 417	112.8
13	" 452	358.0	" 412	92.2	" 462	20.2	" 78	112.7
14	" 456	317.0	" 489	92.2	" 416	20.0	" 227	112.0
15	" 425	312.0	" 211	91.2	" 388	20.0	" 311	112.0
16	" 493	301.0	" 109	91.0	" 386	19.4	" 416	110.0
Checks	OS 7	253.0	OS 7	101.5	OS 7	13.9	OS 7	79.0
	HFO 114	287.0	HFO 114	79.0	HFO 114	11.7	HFO 114	58.0

EFFECT OF CUTTING DATES AND NITROGEN RATES ON THE FORAGE YIELD AND QUALITY OF OAT UNDER MID-HILL CONDITIONS IN THE KASHMIR VALLEY

M. H. Shah and K. N. Singh

The States of Jammu and Kashmir are located in the northwestern corner of India, between 32^{o}-17′ and 37^{o}-5′ N-latitude and 73^{o}-26′ and 80^{o}-30′ E-longitude. This area has a net sown area of 0.729 million hectares out of the total cropped area of .1010 million hectares or 44% of the net sown area with a cropping intensity of 138.5%. The area under paddy in the valley is .164 million hectares (Anen. 1984-85) which mostly remains mono cropped. Farmers have found great promise with oats under a double cropping system to overcome a fodder deficit and also provide forage during early April when no other green forage is available due to climatic limitations when the entire valley remains dormant from the Agriculture point of view.

The present study was undertaken during 1987-88 at the exotic cattle breeding farm, Manasbal, Sher-e-Kashmir University of Agricultural Sciences and Technology with an objective to find an optimum rate of nitrogen application and interval of defoliation for increased biomass production and quality. The experiment was laid out in a randomized block design with four replications. The treatments comprised six nitrogen levels (0, 20, 40, 60, 80, and 100 kg ha^{-1}) applied in three equal splits. The first split was applied as basal and other two splits at young and milk stages. Oats seed was sown on 25 October at the seed rate of 100 kg ha^{-1} and remained snowbound from December until March. Herbage was harvested at 15 day intervals starting from 5 April and continued until 5 June leaving sufficient time for land preparation and transplantation of paddy.

Critical analysis of the data (Table 1) reveal that green fodder yield increased significantly with the successive levels of nitrogen. Highest herbage yield of 415.18 q ha^{-1} was recorded with 100 kg N ha^{-1} which was 93.6% more over the control and 46.4%, 24.9%, 12.9%, 5.4% more over 20, 40, 60 and 80 kg N ha^{-1}.

Dry matter yield obtained was also higher with 100 kg N ha^{-1} and differed significantly from the rest of the levels except 80 kg N ha^{-1}. The higher rates of biomass production through the application of nitrogen may be attributed to the growth attributing characters Viz., plant height, leaf and tiller number and over all vegetative growth. Such results were also reported by Bokade, 1988a and Lal and Bajpai, 1974.

Nitrogen application also improved percent protein content (Table 1) on a dry matter basis and decreased crude fiber content with the successive levels of nitrogen. The experimental results reveal that the highest protein content (12.96%) was recorded with correspondingly low crude fiber content (27.29%) with applications of 100 kg N ha^{-1}. Thus increasing succulency, palatability and intake ability while as reverse has been the case with regard to defoliation intervals. The highest protein content was recorded at preflowering stage and declined thereafter while crude fiber showed an increasing trend with the age.

The results further reveal that highest fresh forage yield was recorded when defoliation occurred on 5 May, 30 days after the first defoliation (5 April) but was similar to 20 April defoliation treatments statistically. Defoliation beyond 5 May reduced the fresh herbage yield significantly which may be attributed to the higher rate of lignification. The data clearly suggests that the dry matter production increased signficantly with delayed defoliation and the highest yield of dry matter (165.68 q ha^{-1}) was recorded when defoliation was done on 5 June compared to 5 April (95.18 q ha^{-1}).

References

Anonymous (1984-85). Digest of Statistics. Directorate of economics and statistics, planning and development, J&K.

Bokade, S. 1968a. Effect of different levels of nitrogen application and cutting intervals on growth, yield and quality of two varieties of oat. I. Oat grown for fodder. Indian J. Agric. Sci. 38:887-909.

Lal, H., and Bajpai, M. R. 1974. Effect of levels of nitrogen, phosphorus and cutting intervals on growth, yield and forage quality of oats (Avena sativa L.) Univ. Udaipur Res. Studies.

Table 1. Effect of different levels of nitrogen and defoliation intervals on fresh weight, dry matter yield and quality of oat (1987-88).

Treatment	Fresh yield (q/ha^{-1})	Dry matter yield (q ha^{-1})	Protein (%)	Crude fiber (%)
Nitrogen levels (kg ha^{-1})				
0	214.44 f*	82.27 e	8.72 f	30.88 a
20	283.58 e	105.20 d	9.97 e	30.61 a
40	332.22 d	122.09 c	11.60 d	29.82 b
60	367.65 c	147.13 b	11.99 c	29.10 c
80	393.70 b	165.61 a	12.83 b	28.63 d
100	415.18 a	166.16 a	12.96 a	27.29 e
SEm±	4.07	0.79	0.03	0.07
CD (0.05)	12.84	2.47	0.10	0.21
Defoliation intervals				
5 April	311.31 c	95.18 e	8.62 b	26.20 e
20 April	359.56 a	103.93 d	8.93 a	27.25 d
5 May	369.13 a	133.75 c	8.60 b	29.70 c
20 May	339.30 b	158.51 b	7.90 c	30.68 b
5 June	293.00 d	165.68 a	6.30 d	30.98 a
SEm±	4.72	0.87	0.04	0.09
CD (0.05)	14.88	2.75	0.12	0.25

*Any two treatment means followed by the same letter do not differ significantly with each other.

EVALUATION OF SOME OAT ACCESSIONS FOR FORAGE YIELD IN MULTICUT SYSTEMS

R. N. Choubey and S. K. Gupta

The regular supply and uniform seasonal distribution of forage through repeated cutting/grazing over a longer duration of time are of immense importance. In an earlier communication (Oat Newsletter, 38:24-25), the performance of some exotic collections for forage yield in a single cut system was presented. The present study was undertaken to assess the performance of some of these exotic oat accessions along with some new introductions for forage yield under a multicut system so as to identify suitable parental lines combining regeneration capacity for hybridization programs.

The experimental material utilized in the present experiment was comprised of 7 oat varieties from Mexico and 4 oat collections from the U.S.A. A released variety for a multicut system, UPO-94, was used as the check. The experiment was conducted in a randomized block design with 3 replications at the Central Research Farm of the Indian Grassland and Fodder Research Institute, Jhansi during the winter season of 1987-88. Plots consisted of 5 rows 3 meters long with a 30 cm row spacing. The data for green forage and dry matter yields were recorded for two cuttings, first cut at 60 days after sowing and second cut at fifty percent flowering. The observations were subjected to analysis of variance and the varietal differences for green forage and dry matter yields were found to be significant in both the cuts. The total forage yield pooled over the cuts also exhibited significant differences among the genotypes.

Green forage yield ranged from 128.90 to 276.43 q/ha in the first cut and 88.80 to 371.80 q/ha in the second cut (Table 1). The cumulative yield over the cuts ranged from 331.80 to 607.37 q/ha. In the first cut, 'Cuauhtemoc' produced the maximum green forage yield (276.43 q/ha) followed by 'Diamante' (262.23 q/ha) and 'Chihuahua' (235.57 q/ha). In the second cut, Chihuahua produced the maximum green forage yield (371.80 q/ha) followed by 'PA 8224' (354.03 q/ha). These two varieties also were better than all the entries for total green forage yield.

Mean performance of genotypes for dry matter yield (Table 1) ranged from 19.77 to 36.20 q/ha in the first cut and 16.80 to 67.23 q/ha in the second cut. The total yield pooled over the cuts ranged from 45.97 to 96.13 q/ha. As in the case of green forage yield, the highest yielding genotypes with respect to dry matter yield were Cuauhtemoc (36.20 q/ha) in the first cut and Chihuahua (67.23 q/ha) in the second cut. Dry matter yield pooled over the two cuts was also found to be highest with the variety Chihuahua (96.13 q/ha) followed by PA 8224 (96.33 q/ha) as in case of green forage yield. Both these strains outyielded the national check variety 'UPO-94' by a margin of 20.3 and 19.3 percent, respectively.

Under a repeated cutting/grazing system, the performance of the genotype after each cut is of prime importance. However, in the present study, the observations are limited to two cuts only. In addition to regeneration capacity, the performance of the genotype after each cutting/grazing, and the performance of the variety in initial cut as well as its cumulative yield over the cuts are also of importance. The results of the present study indicate that the genotypes such as Chihuahua, having the highest performance both for green forage and dry matter yield in the second cut, possess high regeneration capacity. This variety, showing maximum forage yield pooled over the cuts, also possesses good yielding ability in the initial cut. Thus, the genotype Chihuahua may be used as a promising parent in a hybridization program for breeding varieties suitable for multicuts. The other varieties such as PA 8224, 'Pennline-6571' and Cuauhtemoc used in the present study also possess promise for their use as donors for high regeneration ability in breeding programs leading to the development of multicut oats.

Table 1. Mean performance of different oat accessions for green forage and dry matter yields in multicut system.

		Green forage yield (q/ha)			Dry matter yield (q/ha)		
S.N.	Accessions	1 cut	2nd cut	Total	1 cut	2nd cut	Total
1.	UPO-94 (Check)	164.47	384.77	502.57	19.77	60.13	79.90
2.	Tulancingo	217.77	170.33	388.10	23.80	30.93	54.73
3.	Gena	164.47	319.97	504.43	21.03	57.60	78.63
4.	Huamantla	168.90	162.90	331.80	22.23	29.40	51.63
5.	Chihuahua	235.57	371.80	607.37	28.90	67.23	96.13
6.	Pennline-6571	208.90	342.17	551.07	25.43	62.27	87.70
7.	Guelatao	215.57	162.90	378.47	23.43	29.27	52.80
8.	Diamante	262.23	88.80	351.03	29.17	16.80	45.97
9.	Cuauhtemoc	276.43	281.43	584.53	36.20	50.73	91.47
10.	PA 8224	222.43	354.03	589.27	32.07	63.27	95.33
11.	Florida-501	128.90	251.80	400.70	23.10	45.40	68.50
12.	Florida-502	151.10	268.07	429.17	21.10	48.20	69.30
	C.D. (5%)	74.09	59.61	95.85	6.69	10.59	14.40

FORAGE QUALITY OF OATS UNDER DIFFERENT SOWING DATES AND CUTTING MANAGEMENT

Bhagwan Das and K. D. Taneja

In India oats are grown during the winter season. The planting starts in late October and continues through December. However, no information is available regarding date of sowing and the cutting management to ensure optimum yield and quality.

To obtain this type of management information, three varieties namely Kent, OS-6 and HFO-114 were sown on different dates such as 31 Oct., 15 Nov., 30 Nov., 15 Dec. and 30 Dec. in a split plot design with three repliations at the farm of Haryana Agricultural University. Recommended amounts of nitrogen and phosphorus were applied. Two cutting management systems were used. In the first system, two cuts were taken, the first 60 days after sowing followed by the second cut at 50% flowering. In the second system only one cut at 50% flowering was taken.

Samples from these treatments were taken accordingly, dried, and ground. These were analyzed for crude protein and *in vitro* dry matter digestibility.

Protein as well as digestibility percentage decreased in the second cut and the variety OS-6 gave the highest crude protein as well as digestible dry matter (Table 1). The highest protein percentage, 13.27, was obtained in the first cut with a 30 Nov. sowing date and similarly this sowing date produced the highest *in vitro* dry matter digestibility (76.40%). There was not much variation in protein percentage in the second cut under different dates of sowing but digestibility percentage was minimum with a 30 Nov. sowing date. However, crude protein and digestible dry matter yields were highest with a 30 Nov. sowing date.

The data in Table 2 reveals that under the one cut system the variety OS-6 also produced the highest crude protein and digestible dry matter yields and the 15 Nov. sowing date appeared optimum followed by 31 Oct.

The present results indicate that OS-6 is the most promising under both the systems of cutting management. Nov. 15 appeared to be the optimum date of sowing under single cut whereas 30 Nov. was for two cut.

Table 1. Chemical composition of oat forage under different dates of sowing and cutting management.

Varieties/ Treatment	CP %		IVDMD %		CP Yield (q/ha)			DDM Yield (q/ha)		
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	Total	1st cut	2nd cut	Total
Varieties:										
Kent	10.36	9.49	67.28	59.60	4.29	5.34	9.63	27.89	33.55	61.44
OS-6	11.32	9.31	69.16	55.60	5.98	6.48	12.46	36.56	38.73	75.29
HFO-114	11.50	8.61	67.52	51.96	5.03	5.57	10.60	29.53	33.61	63.14
Dates of sowing:										
31 Oct.	10.28	9.84	60.40	66.13	4.69	6.36	11.05	27.59	42.78	70.37
15 Nov.	11.00	9.40	71.40	56.60	5.30	7.09	12.39	34.41	42.72	77.13
30 Nov.	13.27	8.53	76.40	49.20	9.51	6.33	15.84	54.75	36.52	91.27
15 Dec.	8.45	9.55	60.93	51.53	3.11	5.33	8.44	22.40	28.74	51.14
30 Dec.	12.32	8.38	70.80	55.13	3.43	5.59	9.02	19.72	26.22	45.94

CP = Crude protein; IVDMD = *In vitro* dry matter digestibility;
DDM = Digestible dry matter.

Table 2. Chemical composition of oat forage under different dates of sowing and cutting management, (one cut taken at 50% flowering stage).

Varieties/ Treatment	CP %	IVDMD %	Yield (q/ha) CP	Yield (q/ha) DDM
Varieties:				
Kent	8.09	59.32	8.41	61.64
OS-6	7.69	55.40	10.19	73.39
HFO-114	8.04	56.20	9.06	63.31
Dates of sowing:				
31 Oct.	8.75	57.73	12.04	79.47
15 Nov.	7.87	61.60	10.53	82.44
30 Nov.	9.26	61.20	8.57	56.68
15 Dec.	8.31	59.07	9.85	70.05
30 Dec.	5.54	45.27	5.48	44.79

FORAGE PRODUCTIVITY OF OATS UNDER BLACK SIRIS AND SHISHAM PLANTATIONS

R. S. Dhukia, D. S. Jatasra and Shardha Ram

The need of increasing fodder production is obvious from the fact that a wide gap exists between fodder availability and requirement of Indian livestock. The area under forage production is very low and it cannot be increased further due to competition with feed crops. Hence, forage production will have to be enhanced without increasing the forage production to narrow down this gap. Production of forages under a tree component is one of the alternatives to increase forage production. The present study was undertaken to evaluate the potential of producing additional fodder from oats (Avena sativa L.) under an agro-forestry system.

A field experiment on oats was conducted during 1985-86 and 1986-87 in interspaces of black siris (Albizzia lebbek) and shisham (Dalbergia sissee) at Haryana Agricultural University, Hisar, India. These trees were planted during 1983 with a spacing of 5x5 m. Oat variety OS 7 was sown in November during both years, using a seeding rate of 75 kg/ha with 25 cm row-spacings in a randomized block design having three replications in 80 m^2 plots. The crop was fertilized with 40 kg N/ha at sowing and was harvested for fodder at 50 percent flowering.

The green fodder and dry matter yields were higher during 1985-86 under both the plantations (Table 1). Average yields of 288.45 q/ha of green fodder and 46.85 q/ha of dry matter were obtained when oat was raised in interspaces of black siris. The corresponding yields under shisham plantation were 312.75 and 65.50 q/ha. Decline in forage production during 1986-87 under both the plantations revealed an antagonistic relationship between the forage yields and age of the trees.

A critical comparison of green fodder yield under two plantations indicated that oats produced more green fodder under shisham plantation with an 8.42 percent average increase over the black siris plantation. A similar trend was also observed for dry matter yield. However, the percent increase for dry matter yield under shisham trees was more pronounced in comparisons of green fodder yield. A mean percent increase of 39.81 was recorded for dry matter yield under shisham trees.

From the foregoing discussion, it is now evident that oats can be raised under three and four year old plantations of black siris and shisham. However, a depressive affect of tree-age was observed on forage yield of oats. Also, oats produced higher forage yield under shisham than black siris plantations with a more pronounced percent increase in dry matter production.

ACKNOWLEDGEMENTS

Authors are grateful to the Head, Department of Farm Forestry and Director of Research, Haryana Agricultural University, Hisar for providing facilities.

Table 1. Green and dry fodder yields (q/ha) of oats in agro-forestry system under shisham and black siris plantations.

Duration	Green fodder yield			Dry matter yield		
	Black siris	Shisham	Percent increase	Black siris	Shisham	Percent increase
1985-86	330.70	348.40	5.35	53.30	72.50	36.02
1986-87	246.20	277.10	12.55	40.40	58.50	44.80
Mean	288.45	312.75	8.42	46.85	65.50	39.81

PERFORMANCE OF FORAGE OATS IN AN AGRO-FORESTRY SYSTEM UNDER DIFFERENT SPACINGS OF POPLAR (POPLUS DELTOIDES) PLANTATION

R. S. Dhukia, D. S. Jatasra and Shardha Ram

Oats is an important winter cereal forage in Northern India and is becoming popular among the farmers as it produces more dry matter with less irrigation than forage legumes. Therefore, studies were undertaken to assess oats (Avena sativa L.) productivity under poplar tree plantation with different spacings and to seek the possibilities of additional and regular income with tree components raised under an agro-forestry system.

Field studies on oats were conducted during 1986-87 in interspaces of 5-year old poplar planted at 2x2 m, 4x4 m and 6x6 m spacings with a plot size of 19.2 m^2, 36 m^2, and 60 m^2, respectively at Haryana Agricultural University, Hisar. Oats variety OS 7 was drilled in November using a 75 kg/ha seeding rate with 25 cm row spacings in a randomized block design. The crop was harvested for green fodder at 50 percent flowering.

Oats planted in 6x6 m interspaces of poplar produced maximum green fodder and dry matter yield which was 80.5 percent and 91.7 percent higher than that raised in 2x2 m (Table 1), respectively, and the corresponding percent increase in green fodder and dry matter yields was 34.1 and 29.4, respectively than in 4x4 m. Oats sown in interspaces of 4x4 m of poplar showed percent increases of 34.6 and 48.2 in green and dry matter production parameters as compared to that in 2x2 m. Thus, oats under interspaces of 2x2 m and 6x6 m yielded minimum and maximum, respectively. It is obvious that good yields of oats can be obtained in interspaces of 5-year old poplar planted at 6x6 m spacings under an agro-forestry system.

To sum up the present findings, it is concluded that green fodder from 175.4 to 316.7 q/ha and dry matter of 47.1 to 90.3 q/ha could be obtained from oats grown in the interspaces of 5-year old poplar plantations, depending on tree-spacings. Also a negative association was observed between forage productivity of oats and tree-spacings. As such, additional forage yields from oats under poplar plantation should be taken to augment fodder production in the country.

ACKNOWLEDGEMENTS

Authors are thankful to the Head, Department of Farm Forestry and Director of Research, Haryana Agricultural University, Hisar for providing facilities for the above studies.

Table 1. Green and dry fodder yield (q/ha) of oats in agro-forestry system under various spacings of poplar plantation.

Spacing	Yield (q/ha) Green fodder	Yield (q/ha) Dry matter
2x2 m	175.4	47.1
4x4 m	236.1	69.8
Percent increases over 2x2 m	34.6	48.2
6x6 m	316.7	90.3
Percent increase over 2x2 m	80.5	91.7
Percent increase over 4x4 m	34.1	29.4

DWARF OAT VARIETY MORE RESPONSIVE, HIGHER YIELDING

W. K. Anderson and R. J. McClean

The dwarf oat variety Echidna bred in South Australia by A. R. Barr (1984) was tested for its response to sowing date, nitrogen rate and seed rate in field experiments at nine sites in the 500-800 mm rainfall zone in Western Australia over three seasons. It was compared to the short variety Mortlock (Portmann et al. 1983) and the standard tall variety West.

Echidna responded more to early sowing and nitrogen fertilizer and required more seed to reach its maximum yield (see table).

In Australia, oats are sown in autumn resulting in a growing season of up to 170 days in contrast to the growing season for spring oats in North America of about 100 days. In our experiments the dwarf variety outyielded the taller types in the longer season conditions created by a late May sowing but not in the shorter season conditions created by a late July sowing (about 120 days). This may help explain why dwarf oats have not outyielded taller oats from spring sowings in North America. (Brown et al. 1980, Marshall et al. 1987, Meyers et al. 1985).

Responses of dwarf, short and tall oats to sowing date, nitrogen fertilizer and seed rate.

Variety	Average height (cm)	Grain yield (t/ha) Late May	Late June	Late July	Response to N (kg/ha/kgN)	Optimum seed rate (kg/ha)
Echidna	70	3.72	3.12	1.08	14	77
Mortlock	91	3.30	2.80	1.01	8	67
West	104	3.10	2.60	0.76	2	61

References

Barr, A. R. 1984. J. Aust. Inst. Agric. Sci. 50:123.

Brown, P. D., McKenzie, R.I.H. and Mikaelsen, K. 1980. Crop Sci. 20:303.

Marshall, H. G., Kolb, F. L., and Roth, G. W. 1987. Crop Sci. 27:572.

Meyers, K. B., Simmons, S. R., and Stuthman, D. D. 1985. Crop Sci. 25:964.

Protmann, P. A., McLean, R. J., Fisher, H. M., and Crosbie, G. B. 1983. J. Aust. Inst. Agric. Sci. 49:233., Western Australian Dept. of Agric., Baron-Hay Court, South Perth, WA 6151, Australia.

CHARACTERISTICS OF C_3 PROGENIES OF INDUCED *AVENA STRIGOSA* TETRAPLOIDS

R. N. Choubey, S. K. Gupta, and S. N. Zadoo

Polyploidy has played an important role in the evolution of the genus *Avena* L. which comprises various diploid, tetraploid and hexaploid species. Keeping these facts under consideration, a polyploidy breeding program involving the diploid oat species *A. strigosa* Schreb. has been taken up at the Indian Grassland and Fodder Research Institute, Jhansi. The objective is to utilize the induced polyploids for restoration of fertility in sterile interspecific hybrids, as a bridge for interspecific crosses and/or for direct utilization as a fodder variety.

During the winter season of 1985-86, germinating seeds of *A. strigosa* were placed in 0.1 percent aqueous solution of colchicine for six hours. The treated seedlings were raised in pots and transplanted after 20 days of growth. In the C_0 generation, seven plants with sectorial chimeras could be isolated on the basis of swollen pedicel tips which acted as a marker to identify induced tetraploid plants/sectors.

In 1986-87, thirty C_1 plants were successfully raised and observed to possess chromosome numbers varying from 2n=27 to 29. The seed fertility, pollen stainability and pollen size varied among these plants. The cytological analysis of these plants revealed that 26 plants were euploid with chromosome constitution of 2n=4x=28. Three plants had 2n=(4x+1)=29 chromosomes while a single plant was observed to have 2n=(4x-1)=27 chromosomes. Pollen stainability percentage varied from 68.47 to 95.23 percent as compared to 98.6 percent of the diploid progenitor (Zadoo, Choubey and Gupta, 1988).

Inspite of the reduced seed fertility and pollen viability, ample seed set was obtained in the C_1 plants. Two cycles of selection for seed fertility were performed during the C_1 and C_2 generations. The C_3 progenies from the selected C_2 plants were sown in October 1988 and a wide range of variation for the morphological traits has been observed between various progenies (Table 1). Within progeny variation was not apparent indicating that most of the progenies were stable.

Some progenies of the induced tetraploids of *Avena strigosa* exhibited longer and wider leaves than the diploid (Table 1). The number of spikelets per panicle was lower in many progenies while some progenies had higher number of spikelets per panicle than the diploid parent. Spikelets were larger than those of diploids in all the progenies.

In general, the tetraploids flowered 10-15 days later than the diploid and some tetraploid progenies attained increased height. The preliminary observations indicate that the tetraploids of *Avena strigosa* may be more desirable for forage, especially for mixing with legume forages viz. Egyptian clover and alfalfa.

Reference

Zadoo, S. N., Choubey, R. N., and Gupta, S. K. 1988. Cytogenetics of induced tetraploids of *Avena strigosa* Schreb. Cell Chr. Res. 11:13-18.

Table 1. Morphological characteristics of induced tetraploid and natural diploid progenies of *Avena strigosa*.

Observations	Tetraploid		Diploid	
	Range	Mean	Range	Mean
1) Plant height (cm)	77-141	130.50	126-135	128.20
2) Leaf no./tiller	6-7	6.20	6	6.00
3) Leaf length (cm)	17-42	31.26	25-28	26.50
4) Leaf width (cm)	1.2-2.6	1.58	1.3-1.4	1.35
5) Panicle length	25-37	30.60	27-31	29.00
6) No. of spikelets/panicle	61-165	116.30	109-137	121.50
7) Length of spikelet (cm)	2.2-2.7	2.46	1.6-2.0	1.82

PLANT VARIETY PROTECTION OFFICE PROGRESS REPORT

Eldon E. Taylor, Examiner

From enactment of the Plant Variety Protection Act (Act) in 1970 to January 1, 1989, a total of 2,786 applications were received and 2,133 certificates of protection were issued. As of January 1, 1989, the Plant Variety Protection Office (Office) had received 30 applications for protection of oat cultivars, only one of which was received in 1988. Seventeen of the oat applications are from experiment stations. A total of 21 certificates have been issued on oat cultivars. There were 4 oat applications pending on January 1, 1989.

Of the 21 certificates issued on oat varieties, 20 specified that the variety was to be sold by variety name only as a class of certified seed. Five oat applications have been abandoned, withdrawn, or found ineligible since the Office began processing applications.

The Office solicits descriptions of varieties which are being released without variety protection. Only adequate descriptions of existing varieties can preclude issuing certificates on varieties identical to previously released varieties. We would appreciate copies of any descriptions prepared for other organizations, such as the Certified Small Grain Variety Review Board of AOSCA. However, Review Board information is not used by the Office unless permission is granted by the applicant.

Application forms, Exhibit C forms (Objective Description of Variety) and information may be obtained from:

Plant Variety Protection Office
Commodities Scientific Support Division, AMS
U.S. Department of Agriculture
National Agricultural Library Building, Rm. 500
Beltsville, Maryland 20705
(301) 344-2518

Application should be made to the above address on Form LS-470 along with the necessary exhibits and at least 2500 viable untreated seed of the variety. The filing and search fee of $1800 is payable by check or money order to the "Treasurer of the United States" at the time of application. The required exhibits and their contents are listed and described on the application form. Applications will not be filed until all required exhibits, fees and seed are received in the Office. A $200 allowance (issuance) fee will be requested by the Office when the search is completed and the application variety is deemed eligible for a certificate of protection. A proposal to raise the fees for plant variety protection to $2400 has been published in the Federal Register. A final rule making this fee increase effect is currently being processed.

In Fiscal Year 1988, the Office received a total of 238 applications and issued 215 certificates. During the first 3 months of Fiscal Year 1989, 69 new applications were received and 53 certificates were issued. As of January 1, 1989, the Office was in the process of examining 276 applications for protection. To sustain these examinations, examiners continually update, expand, and revise computerized variety description files for more than 100 different crops.

The following table summarizes the status of all applications in the Plant Variety Protection Office as of January 1, 1989:

Total applications received	2,786
Total applications received from foreign countries	246
Total applications received from public institutions	306
Total applications abandoned, ineligible, withdrawn, or denied	377
Total certificates issued	2,133
Total certificates in force	2,122
Total certificates issued as certified seed only	693
Total applications pending final action	276

The breakdown of applications pending final action is as follows:

Certificate stage	43
Search stage	98
Extended time	30
Pending examination	105
Reconsideration	0

Class Breakdown of:

Applications Received:			Certificates Issued:		
1,881	agricultural	67.5%	1,444	agricultural	67.7%
136	ornamental	4.9%	92	ornamental	4.3%
769	vegetable	27.6%	597	vegetable	28.0%

Certificates have been issued in 83 crops. The greatest number of certificates have been issued in the following 20 crops:

soybean	483	corn	112	barley	38	onion	25
wheat	201	lettuce	85	bluegrass	41	tobacco	23
pea	193	fescue	75	marigold	40	oat	21
bean	174	ryegrass	70	tomato	31	cauliflower	20
cotton	160	alfalfa	58	watermelon	25	rice	19

The following is a summary of the number of applications received/ certificates issued by fiscal year:

FY71	110/0	FY76	81/85	FY80	166/125	FY85	219/155
FY72	149/0	TQ76*	18/28	FY81	177/108	FY86	164/208
FY73	102/6	FY77	112/140	FY82	191/153	FY87	214/205
FY74	109/98	FY78	106/100	FY83	179/142	FY88	238/215
FY75	105/104	FY79	120/88	FY84	157/120	FY89	69/53

(* TQ indicates the transitional fiscal quarter - July 1, 1976 to September 30, 1976 when the government of the United States changed fiscal reporting periods.)

OAT PRODUCTION AND BREEDING AT THE UNIVERSITY OF PASSO FUNDO

Elmar Luiz Floss

PRODUCTION

During the last ten years (1978/1987), the acreage and the production of oats have increased in Brazil. In 1987, 139,711 ha of grain oats were cultivated, 151% more than in 1978. Production of grain was 175,797 metric tons, 225% higher than 1978. The yield average obtained in 1987 was 1,258 kg/ha. Crown rust (Puccinia coronata Cdo.) is the most important disease limiting the oat production. Beyond the genetic resistant or tolerant cultivars released, most of the larger farms use fungicides, but most of smaller farms do not. The cultivar UPF-5, which was released by the University of Passo Fundo in 1985, is currently the leading oat cultivar in Brazil.

The most important production regions are in the states of Rio Grande do Sul, Parana and Santa Catarina (South Brazil). In 1976, Brazil imported 37.2% of oats consumed, and in 1987, only 7.9%. About 25,000 metric tons are used for human food while most were utilized for feed, especially for horses.

In South Brazil, oats are the most important winter crop for pasture, planted isolated or associated with ryegrass, rye or legumes. An estimated area of 300,000 ha of pasture oats, mostly Avena strigosa, were grown in this region.

During the last few years increased cultivation of oats for winter soil cover has become important in soil erosion control. Utilization of oats in this system is also important for control of the wheat disease "take all" (Gauenmanomyces graminis f. sp. tritici), weed control and to form a "mulching" for soybean sown in the summer, through the no tillage system.

OAT BREEDING

The oat breeding program started at the University of Passo Fundo in 1977 was based mainly on genetic material (pure lines and segregating material /F3) introduced by the project "Breeding Oat Cultivars Suitable for Production in Developing Countries". The main objective of the program is the development of new oat varieties with higher yield potential, better adaptability to the different regions, better grain quality and resistance to the most important diseases, such as leaf rust (Puccinia coronata Cdo.), stem rust (Puccinia graminis f. sp. avenae) and Barley Yellow Dwarf Virus (BYDV).

From 1977 to 1988, twelve new cultivars were released with a significant improvement over the older cultivars Coronado and Suregrain. Pedigrees, yield and other phenotypic characteristics of the new UPF cultivars and comparison with common cultivars Coronado and Suregrain are presented in Table 1.

ALUMINUM TOLERANCE IN OATS

Aluminum toxicity is an important limiting factor for oats growth in many acid soils in South Brazil. A breeding program for selection of genotypes with Aluminum tolerance was started in 1986 at the University of Passo Fundo. In the last two years (1986/1987) the Quaker nursery was sown in acid soils, with 3.7-3.9 me Al/g soil. The best tolerance to Al during the past two years was exhibited by the pure lines CI9020 (Avena strigosa), Steele, UPF10 (UPF79331-1) and EEA 10/2/ x2503/ x2299/3/EFA10. From the segregating F_3 material single panicles were selected from tolerant plants.

Table 1. Identification, pedigrees and other characteristics of the UPF oat cultivars released from 1977 to 1988.

Cultivar	Release (year)	Pedigree	Days to head	Plant height (cm)	Test weight (kg/hl)	Kernel weight (mg)	Yield* (kg/ha)	%
UPF-1	1981	FLAx63-46(AB113)	104	117	53.0	24.8	1.577	132
UPF-2	1982	X2505-4	110	120	56.5	19.9	1.371	114
UPF-3	1984	Coronado x X1779-2	98	120	47.3	26.1	1.868	156
UPF-4	1984	X2055-1	95	117	45.6	23.5	1.526	127
UPF-5	1985	X2185-1 x ILL1514	104	128	48.9	31.4	1.824	152
UPF-6	1986	Coker 1214 x LANG	99	127	56.5	27.6	2.071	173
UPF-7	1986	TCF x X2503-1	98	109	55.3	25.6	2.230	186
UPF-8	1986	X2505-4 x OTEE	109	100	48.4	23.7	1.669	139
UPF-9	1987	79BVL3109	96	104	51.9	28.0	1.622	135
UPF-10	1987	1040 GH Double x short	101	134	52.6	28.4	1.877	157
UPF-11	1987	1563 CR cpx/SR cpx	99	127	55.7	27.4	2.132	178
UPF-12	1988	IN73-109 x PC25	105	145	59.0	30.7	2.617	219
Coronado (CK)			105	113	53.6	30.5	1.418	118
Suregrain (CK)			105	109	50.5	27.6	1.197	100

*Average from five years at six different locations (1983-1987).

OATS IN MANITOBA - 1988

P.D. Brown, S. Haber, J. Chong and D.E. Harder
Agriculture Canada, Research Station, Winnipeg, Manitoba

Growing conditions in 1988 were above average - above average heat and above average drought. In April and early May, warm, dry and windy weather conditions prevailed resulting in severe soil erosion. Uneven soil moisture levels caused some problems with uneven germination. The few showers that did fall were preceeded and followed by above average temperatures. There was minimal tillering. The heat and drought are being blamed for crop yield reductions of 33 - 50 % in southern Manitoba.

In Manitoba, 216,900 ha of oats were planted in 1988. The variety Dumont was planted on 52% of the area, Fidler was planted on 24% of the area and Riel was planted on 15% of the area planted to oats. The production of pedigree seed with 1474 ha of Dumont, 24 ha of Fidler, and 1034 ha of Riel indicates that the variety Fidler will slowly disappear from the fields of Manitoba. A total of 36 ha of select, foundation and registered seed of the recently registered variety Robert were grown in Manitoba in 1988.

As in previous years, the most serious economic viral disease problem in oats in Manitoba was aphid-borne barley yellow dwarf virus (BYD). Aphid suction traps at the Glenlea experimental farm south of Winnipeg yielded viruliferous aphids as early as May 10 due to sustained, warm southerly winds. Because the drought depressed yields in 1988, losses specifically attributable to BYD were lower in 1988 than in 1987. In areas that escaped the worst effects of drought, BYD occurred in localized patches.

Among BYDV isolates obtained in the surveyed areas of Manitoba, approximately 85% were identified by transmission and serological tests as 'PAV-like' in that they were most efficiently transmitted by the oat bird-cherry aphid but were also transmitted by the English grain aphid. As in previous years the English grain aphid was the most commonly observed vector cereal aphid. For the purpose of selecting BYD-tolerant lines in disease nurseries, a virulent PAV-like isolate will continue to be used.

Oat seedlings grown in greenhouses at Winnipeg in August, 1988 developed striate mosaic symptoms that continued to develop in newly emerging leaves even after transfer to contained facilities. Examination in the electron microscope revealed the extensive presence of rhabdovirus particles in leaves with the striate mosaic symptoms, and the absence of such particles in symptomless plants. The particles were approximately 70x230 nm and were found in the perinuclear space rather than in the cytoplasm. The observed symptoms were similar to those reported by Jedlinski in the description of oat striate mosaic rhabdovirus from Illinois in 1976. The 1988 Winnipeg oat rhabdovirus associated with striate mosaic symptoms also resembled the Illinois oat rhabdovirus in its perinuclear distribution of particles. The Winnipeg virus clearly differed from the one reported from Illinois with respect to particle size: 70 x 230 nm as opposed to 100 x 400 nm for the Illinois oat rhabdovirus. The hot dry conditions which prevailed in the summer of 1988 in Manitoba favored the build-up of large populations of cicadellid leafhoppers, and it was not always possible to exclude leafhoppers from greenhouses. These observations of oat striate mosaic-like disease, presumably caused by a leafhopper-transmitted rhabdovirus, are the first from western Canada.

The incidence of oat crown rust in Manitoba in 1988 was the lightest reported in recent years. Although the earliest infections were detected on June 28, 1988, the subsequent hot and dry conditions severely restricted their development. Only trace levels of crown rust were found late in the growing season. This very low incidence resulted in very few field collections made in 1988. Seventy-four isolates, comprising 27 virulence combinations, were identified. The most prevalent isolates were ones that were virulent on plants with genes Pc35, Pc40, or Pc46. None of these posed a potential threat to the current rust resistant cultivars of the eastern prairies.

Oat stem rust infections were very light across western Canada in 1988, and no significant damage was recorded. The virulence survey for 1988 (Table 1) included samples from eastern and western Canada. A much wider range of virulence was detected in 1988 than is usual, particularly from Manitoba. In Manitoba 13 races were found as compared to 3 or 4 which are normally found. Also, race NA 5, which is a typical race in the Pacific stem rust populations was detected in Manitoba. Normally a single race, NA 27, overwhelmingly predominates in the prairie rust population, but in the light rust year of 1988, the overwhelming effect may have been reduced, allowing other races to be sampled.

Table 1. Frequency of races of _Puccinia graminis_ f. sp. _avenae_ collected from field surveys and from trap nurseries in Canada in 1988.

Race	Avirulence/virulence formula (Pg genes)	Ontario General		Manitoba General		Alberta General		Ontario Trap		Manitoba Trap		Br. Col. General		Total	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
NA 5	1,2,4,8,9,13,16,a / 3,15			1	0.9	7	63.6			1	2.2	8	47.1	17	4.1
NA 6	1,2,4,8,13,16,a / 3,9,15					1	9.1							1	0.2
NA 10	1,4,8,9,13,16,a / 2,3,15					3	27.3					7	41.2	10	2.4
NA 11	1,8,9,13,16,a / 2,3,4,15			1	0.9									1	0.2
NA 12	1,8,13,16,a / 2,3,4,9,15	11	6.4	2	1.7			1	1.9					14	3.4
NA 16	2,4,9,13,15,16,a / 1,3,8			4	3.4					3	6.5			7	1.7
NA 18	2,4,9,13,16,a / 1,3,8,15	1	0.6	6	5.2					2	4.3			9	2.2
NA 20	3,8,13,16,a / 1,2,4,9,15	4	2.3					1	1.9					5	1.2
NA 23	4,9,13,15,16,a / 1,2,3,8			1	0.9									1	0.2
NA 25	8,13,16,a / 1,2,3,4,9,15	54	31.2	4	3.4			10	18.9					68	16.3
NA 26	8,16,a / 1,2,3,4,9,13,15	14	8.1					14	26.4					28	6.7
NA 27	9,13,15,16,a / 1,2,3,4,8	68	39.3	70	60.3			18	34.0	22	47.8			178	42.8
NA 29	9,13,16,a / 1,2,3,4,8,15	15	8.7	21	18.1			5	9.4	14	30.4			55	13.2
NA 30	13,16,a / 1,2,3,4,8,9,15			2	1.7			1	1.9					3	0.7
NA 32	1,8,16,a / 2,3,4,9,13,15							1	1.9					1	0.2
NA 34	1,3,4,8,16,a / 2,9,13,15							1	1.9					1	0.2
NA 35	2,4,8,13,16,a / 1,3,9,15											1	5.9	1	0.2
NA 54	3,8,16,a / 1,2,4,9,13,15	1	0.6					1	1.9					2	0.5
NA 56	1,2,8,9,13,16,a / 3,4,15			2	1.7									2	0.5
NA 61	4,8,13,16,a / 1,2,3,9,15											1	5.9	1	0.2
NA 62	3,4,8,13,16,a / 1,2,9,15	1	0.6											1	0.2
NA 65	2,3,4,8,13,16,a / 1,9,15	4	2.3							2	4.3			6	1.4
NA 80	13,15,16,a / 1,2,3,4,8,9			1	0.9									1	0.2
NA 81	2,9,13,16,a / 1,3,4,8,15									2	4.3			2	0.5
NA 82	2,9,13,15,16,a / 1,3,4,8			1	0.9									1	0.2
Total		173		116		11		53		46		17		416	

OATS IN CHIHUAHUA MEXICO

J. J. Salmeron- Zamora

Growing Season

In 1988, summer seeding occurred from the beginning until the end of July. Soil moisture was adequate from germination until the grain filling stage. Humid and hot weather resulted in heavy stem rust infection. Susceptible varieties like Paramo had highest infections beginning by the first days of September just during the flowering period. Kernel weight was light as results of the rust infection.

Production

There were 220,326 hectares of oats harvested in Chihuahua. Seventy one percent of the hectarage (155,844) was grown for forage while 29% (64,482) was harvested for grain. The average yield per hectare was 1.2 tons. The value of 1988 oat production was $54,032 million pesos.

The four main oat varieties (with the percentage of the area sown to each) were Paramo (70%) Guelatao (10%), Chihuahua (10%), Cuauhtemoc (10%).

Breeding Program

Five new varieties Babicora, Raramuri, Cusi, Papigochi and Pampas were increased during the 1988 growing season and are being increased under irrigation during 1988-1989 winter season at Chihuahua, Chih. We hope to obtain enough seed for the farmers to plant by the middle of July of this year.

In our yield trials lines with good resistance to stem rust were the highest yielding materials. Tulancingo and Diamante R-31 were our best check varieties. However, lines such as St. Fe/4-0058-44 Wis//F9 AB-361-79 GH-131 yielded 20% higher than Tulancingo and the line Gtrrez/77694 outyielded Diamante by 83%.

We grew 35 lines introduced from Minnesota, most of which were susceptible to stem rust except lines MN 869503 and M.N. 869508.

Oat-pea Mixture

Most of the oats grown in Chihuahua is used for forage. By mixing peas with oats, the yield and quality of forage can be improved.

The objective of this research was to evaluate forage yield and quality. The oat cultivar was Paramo. The field pea cultivar was Early Perfection. The small grain seeding rate was 100 kg per hectare when seeded with peas and when seeded alone in a pure stand. The pea seeding rate was 200 kg per hectare when seeded with a small grain and when seeded in a pure stand.

All treatments were harvested in two stages of oat development: early heading (Zadoks 51) and medium milk (Zadoks 75).

The results of this study indicated that mixing field peas with oats resulted in small to moderate increases in forage yield and moderate increases in forage quality. Forage yields of the oat-pea mixture were 18% higher than forage of pure oats during early heading stage and 12% higher in medium milk stage. Protein yields per hectare in the oat-pea mixture were 40% higher than in pure oat stand. Pure stands of Early Perfection peas had high percentages of protein and low forage yields.

NICKERSON SPRING OAT BREEDING PROGRAM

Jayne T. Semple

Nickerson has been involved with Spring Oats for the European market for several years now, especially W. Germany, France and the U.K. In 1988 W. Germany was the world's fourth largest producer with 564,000 ha in production, France with 283,000 and the U.K. with 121,000 ha.

As a result of my move to France in October 1986, taking more responsibility for the Winter Wheat program,a company decision was taken to 'freeze' the Spring Oat breeding program but still promote the most advanced lines (F5-F7) where possible. We now have 'KEEPER' which is recommended in the U.K.; the line 8541 in the 2nd year of official trials in the U.K.; the variety 84-7080 which has finished 1st year of B.P.Z. trials in W. Germany and 3 varieties 87-7002, 87-7004, 88-7015 which are in pre-official trials in U.K., France, and W. Germany.

New Program. The opportunity has now arisen to restart the Spring Oat breeding program in W. Germany under the direction of Mike Taylor. Mike welcomes germplasm for observation and trialling, as well as exchange of information and ideas with other breeders. As a close colleague with a keen interest in Spring Oats he hopes to expand the trialling network throughout Europe.

ARKANSAS

R.K. Bacon and E.A. Milus
University of Arkansas

Production

According to the Arkansas Agricultural Statistics Service, acreage planted to oats in 1988 increased to 40,000 acres from the all-time low of 22,000 acres in 1987. Approximately 35,000 acres were harvested for grain with an average yield of 90 bu/A resulting in a total production of 3,150,000 bushels. The 90-bu/A average yield was the highest ever recorded and was 20.8 bu/A higher than the average from the past 10 years. A mild winter and favorable spring conditions probably accounted for the excellent yields. Drought conditions beginning in late spring were similar to those of the rest of the U.S., but unlike the crop in the spring oat regions, most of the winter oat crop in Arkansas was maturing before the moisture deficit became severe. In fact, the dry conditions may have contributed to high yields and excellent quality by reducing disease pressure.

Cultivars and Breeding

The cultivar 'Madison' has topped the state yield trials for the past two years. However, since it has been reported that Madison may lack sufficient winterhardiness for Arkansas, it has not been recommended. The last two winters have been very mild in the state.

This fall, 10 acres of breeder seed were planted for foundation seed production of the experimental line AR 102-5. This line has very good winterhardiness and yield potential. A decision on release will be made after this season.

Personnel

Dr. E.A. (Gene) Milus took the position of small grains pathologist last winter. He had previously been with Colorado State University and Rohm and Haas Seeds. Steve King recently joined the program as a graduate assistant and will be working toward an M.S. degree. He will be investigating the influence of vernalization on selected southern oat genotypes.

GEORGIA

P. L. Bruckner, J. W. Johnson, B. M. Cunfer, and J. J. Roberts
University of Georgia

Production: Oat acreage and production in Georgia were 45 and 72% higher, respectively, in 1987-88 than in 1986-87. According to the Georgia Crop Reporting Service, state oat growers planted 80,000 acres in 1987-88 and harvested 45,000 acres at an average of 63 bushels per acre for a total production of 2,835,000 bushels. A mild winter, adequate and timely precipitation, minimal disease and insect pressure, and a dry harvest season combined to make 1987-88 an excellent oat production year in Georgia.

Breeding: Oat breeding efforts at the Coastal Plain Experiment Station in Tifton have intensified since 1985 but the breeding program remains relatively small. Primary breeding objectives include enhanced cold tolerance and crown rust resistance.

Research: In the southeastern U.S., oat can be utilized as a forage crop, a grain crop, or as a dual purpose forage/grain crop. In Georgia, approximately 50,000 acres of oat is utilized annually as winter forage. Oat research is underway to examine oat forage quality and to determine optimum selection strategy for development of cultivars suitable for dual purpose utilization.

Pattern and extent of *in vitro* forage digestion and microanatomical characteristics of fresh leaves and stems were determined in 'Florida 501' and 'Coker 227' oat cultivars, and compared to those characteristics in two genotypes each of rye, triticale, and wheat. Oat had a thinner stem sclerenchyma cell layer and less stem lignification than other small grain species. Oat leaf bundle sheath cells were more resistant to digestion than leaf bundle sheath cells of wheat, rye, and triticale. Oat leaf tissue was degraded faster and to a greater extent than leaf tissues of wheat, rye, or triticale. However, oat stem tissues were the least digestible. Mean *in vitro* dry matter disappearance (IVDMD) of Florida 501 leaf and stem tissues was 11 and 28% higher, respectively, than mean IVDMD of Coker 227 leaf and stem tissues.

INDIANA

H. W. Ohm, H. C. Sharma (Breeding, Genetics), G. E. Shaner, G. C. Buechley (Pathology), J. E. Foster (Entomology), R. M. Lister (Virology), K. M. Day (Variety Testing), and C. L. Harms (Extension)

Production. Oat production in 1988 is estimated by the Indiana Crop and Livestock Reporting Service at 3.0 million bushels, down 53 percent from 1987. The state average yield of 40.0 bushels per acre was 27 bushels below that of 1987. Oats were seeded on 350,000 acres and oat acreage harvested for grain was 75,000. The varieties Noble and Ogle were grown on 44.9 and 44.3 percent respectively of the state oat acreage.

Season. Near normal precipitation occurred through the first week in April. Fields then began drying rapidly. By mid-April, oat seeding was half completed, and about one week later than normal. At the end of April, oat seeding was 80 percent completed and about 2 days ahead of the 5-year average. Warm, dry weather began early in May and persisted through June. The impact of the drought to oat production was moderated by favorable temperatures. In early June temperatures ranged from 50 (night) to 80 (daytime) degrees F; in mid-June from 60-90, and late June from 65 to 95 degrees F.

By 1 July oat harvest was 52 percent completed and by 24 July it was 67 percent completed. In production fields at the Purdue University Agronomy Farm, oat yields averaged 75.8 bushels per acre in 1988, 75.2 in 1987, 134.9 in 1986, 124.2 in 1985, and 103.4 in 1984.

Research. Emphasis continues to be to incorporate resistance to crown rust and stem rust into elite lines that have tolerance to BYDV. Populations that have several sources of crown rust resistance were screened. Because of the unusually severe drought and severe BYDV infection in 1988, several lines that have excellent tolerance to BYDV were identified.

In the spring of 1988 we assembled a group of oat lines that possibly had slow-rusting resistance. We selected some of these lines for study based on reaction in the field at Iowa State University, as recorded by Abe Epstein and Grace Schuler. We were interested in lines that had a compatible reaction ("S") but a low percent severity of crown rust. Another group of lines were provided by Deon Stuthman at the University of Minnesota. These lines originated from Matt Moore's program and had performed well in the buckthorn nursery. Both *Avena sativa* and *Avena sterilis* are represented in this material. We inoculated adult plants with a culture of race 264B in the spring of 1988 in the greenhouse. Many of the lines showed indications of resistance, but there was considerable variation within most lines. We tested selected progeny in the greenhouse during the fall of 1988, using a mixture of cultures Pc 54, 58, 59, and 62, kindly provided by Abe Epstein of Iowa State University. These cultures produce the following reactions on the crown rust differentials, according to Dr. Epstein:

	P. coronata culture					*P. coronata* culture			
Host line	54	58	59	62	Host Line	54	58	59	62
IAY 345	A	A	V	A	IA X421	A	A	A	A
H 544	A	A			H 382	A	A	A	A
IA D615-16			A		H 441	A		V	A
H 681				A	H 444		A		
H 561	A	A	A	A	IAY 349	V	A	A	A
H 548	A	A			X434	A	V	A	A
IA D634			A	A	Pc38	A	V	A	A
H 547	A	A	V	A	Pc39	A	A	V	A
H 676	A	A	A		Coker-234	A	A	A	V
Amagalon				A	H 677	A	A	A	V
Ukraine	V	A	V	V	MN 5250	A	A		
Trispernia	V	V	V	A	W78286			A	
IAY 344	V	A			H 617-751				A
IA D520			A	A	Pc50	A	V	A	A
TAM-O 312	V	A			H 555	A	A	A	A
IA D504			A	A	TAM-O 301	V	A	A	A
Ascencao	A	A	A	A					

In the fall 1988 test there was still heterogeneity within some lines, but we were able to discern three types of moderate resistance to crown rust in this material. Some lines showed a long latent period, comparable to what we have observed in slow leaf-rusting resistance in wheat. Under our test conditions, 50% of the uredinia on Clintford erupted by the 7th day after inoculation. On some lines 50% of the uredinia did not erupt until the 11th to 15th day. Once uredinia erupted, they were characteristic of a compatible reaction, although they tended to be somewhat smaller than uredinia on Clintford. Another group of lines had distinctly smaller uredinia than those on Clintford, although there was little necrosis associated with them. A third group of lines tended to form telia quickly. In some cases, telia formed directly in lesions, without formation of uredinia. We are testing progeny of individual plants that expressed these various forms of resistance, to prove our preliminary observations.

<u>Equipment</u>. We have custom-constructed a tool bar to mark lengths of head row nursery plots and yield nursery plots, and to 'trim' yield nursery plots for constant row length. The tool bar, attached to a small tractor with a 3-point hitch, is made of 5.2 cm square steel tubing and extends to the right and to the left, 3.3 m beyond the outside edge of the rear tractor wheels. The distance between the outside edges of the rear wheels is 1.5 m. Each end of the tool bar is supported by a small tire attached to the tool bar and by a chain that extends from near the end of the tool bar to the front of the tractor. The tool bar, which spans a distance of 8.1 m, can be folded at four points along its length by hinges for easy transport. The hinges are at points directly behind and at 2 m beyond each rear tractor wheel. Narrow cultivator shovels are bolted onto one end of metal bars that are 2.5 cm diameter and 45 cm long and attached to the tool bar at desired distances by brackets. The brackets are square tubing 10 cm long that slide snugly over the tool bar and are fitted with a bolt that is placed into holes in the tool bar at desired positions. The bolt is held in place by a tension spring. The shanks fit snugly into a 2.5 cm diameter pipe that is 10 cm long, welded to the bracket, and fitted with a bolt and tension spring to adjust the

height of the shank or to detach it. The shanks at either end of the tool bar are attached to the wheel assembly bracket.

To trim nursery plots, a pump is attached to the power take-off shaft of the tractor and a small tank is mounted on the tool bar behind the tractor. A spray nozzle assembly is attached to the appropriate tool bar bracket at the desired position along the tool bar. The spray nozzle assembly consists of a nozzle and two shields, one on either side of the nozzle and 20 cm apart. The shields, similar to the shields of a row-crop cultivator, are made of flat metal, are 25 cm high x 45 cm long and are positioned such that the nozzle is approximately 15 cm behind the front edge of the shields. The two shields glide along the soil surface and can swing back and upward. We apply a nonselective herbicide to trim the plots.

IOWA

K. J. Frey, A. H. Epstein, R. K. Skrdla,
G. A. Patrick, and G. A. Schuler

About 500,000 acres of oats were harvested for grain in Iowa in 1988. Mean yield was 45 bushels per acre so the state production was slightly over 20 million bushels. Oats were sown early in Iowa in 1988 and moisture was adequate for germination and early growth. However, as was true in most of the Midwest in 1988, rains ceased to occur after April and the droughty conditions and high temperatures during the remainder of the oat growing season reduced plant growth and yields materially. Neither crown rust nor stem rust was present in Iowa, but barley yellow dwarf disease was rather severe in many fields. The harvest index of oats in Iowa in 1988 was very high and test weights were good.

Foundation seed of the new oat variety Hamilton was increased to about 2,500 bushels in 1988 and seed is being offered to seedsmen in Iowa and other Midwestern states for the production of registered seed preparatory to general distribution of this variety to Midwestern farmers. Work continues on development of multiline oat varieties based upon the genetic backgrounds of B605-1085, D226-30, and D227-32. Experimental versions of multilines with these three backgrounds, each containing five-seven isolines, will be tested in variety trials in Iowa in 1989. Increases of the isolines are being made in 1989 for use in the multiline varieties.

Because crown rust infections were light on oats throughout the northcentral region, only 43 leaf samples were submitted for the crown rust survey. There appeared to be a shift to races that are virulent on Iowa D640, Coker 234, and IL82-1658, but the numbers of samples were too small to suggest that any significant shift has occurred to date. This apparent shift will bear watching in 1989 and future years.

A study was completed in Iowa using oats to determine the feasibility of developing crop varieties for primary use in low-productivity environments. Generally, selection of crop varieties at experiment stations occurs in high-productivity environments with subsequent use of these varieties for all crop productivity conditions. The study was conducted from yield data of a population of 116 random oat lines tested in 36 yield environments. The trials were classified into low-productivity environments (LPE), medium-productivity environments (MPE) and high-productivity environments (HPE). Among the 12 environments designated as LPE, individual trials were low-yielding due to N efficiency, P deficiency, or heat stress caused by late sowing. Heritability (H^2) was highest in the HPE, but the genetic correlation (r_G) between yields in LPE and HPE was only 0.59. Estimates of r_G between nonstress and P deficient, N deficient, and heat stressed environments were 0.50, 1.08, and 0.06, respectively, indicating that P deficient and heat stressed environments were responsible for the low r_G between yields in LPE and HPE. With 10% selection based on line means in two or four two-replicate trials, the greatest yield gain for production in LPE was predicted to result from selection in MPE, but for selection in 12 six-replicate trials, direct selection in LPE was superior. These predictions were tested in three empirical selection experiments; in two of these direct selection in LPE was superior to indirect selection in HPE. In all three, increased replication improved efficiency of direct selection in LPE. These results confirm that neither HPE nor environments in which heritability is greatest necessarily maximize yield gain for production in LPE.

Several changes have occurred in the ISU oat breeding personnel during 1988. Dr. W. A. (Allen) Miller joined the faculty in Plant Pathology. Prior to coming to Iowa State, Dr. Miller was a post-doc with CSIRO, Australia, where he worked on the molecular biology of the barley yellow dwarf virus. He will be continuing this work at Iowa State. Mr. Mohammad Al Ajlouni from Jordan has joined the small grain project to work on his Ph.D. degree. Gary Atlin completed his Ph.D. degree, and he is now a plant breeder with Biotechnica Canada, Inc. in Calgary, Alberta.

LOUISIANA

S.A. Harrison (Agronomy) and
Rodrigo Valverde (Plant Pathology)

PRODUCTION: The 1987-88 growing season was ideal for the production of oats in Louisiana, and as a result, grain yields, quality, and test weight were quite high. The spring of 1988 was dry and relatively cool. Oat yields as high as 190 bu/acre were recorded in performance trials in north-west Louisiana (Bossier City). The average yield of twelve varieties in the trials was 132 bu/acre. Although no official statistics are kept for oats in Louisiana, acreage in Louisiana was relatively low. The acreage of oats harvested for grain has been in the range of 10,000 to 15,000 acres in recent years. This increased to around 20,000 - 25,000 acres for the 1987-88 season, due to government policies and increased prices. The oat acreage for the 1988-99 growing season may approach 100,000 acres.

BREEDING AND VARIETIES: Information from seedsmen and growers suggest that 'Citation' and '833' are the most widely grown oat varieties in Louisiana. 'Mesquitte II', 'Coker 234 ', 'Coker 227', 'Coker 820', and 'Florida 502' are also grown on measurable acreage. An oat breeding project was initiated during the 1987-88 growing season. The oat breeding project will be on a relatively small scale. The primary objectives of the breeding effort are to develop traditional and naked oat varieties adapted to the warm, humid conditions of Louisiana. Several F2 populations were obtained from Dr. Phil Bruckner (Tifton, GA), and additional crosses were made at Baton Rouge. Most of the crosses made at Baton Rouge were between nuda sources and adapted varieties.

PATHOLOGY: Crown rust, stem rust, barley yellow dwarf virus, leaf blotch (*Helminthosporium*), septoria leaf blotch, and halo blight (*Pseudomonas)* occurred at significant levels in nurseries at Baton Rouge last year. A significant epidemic of halo blight has also been observed in the spring of 1989 at Baton Rouge.

Dr. Rodrigo Valverde joined the Lousiana Agricultural Experiment Station Department of Crop Physiology and Plant Pathology, as a virologist, and will be doing some work with BYDV. During the spring of 1988, leaf samples of wheat and oats showing virus-like symptoms were collected from numerous locations around the state. The enzyme-linked immunosorbent assay (ELISA) with antisera specific for three BYDV strains (RPV, PAV, and MAV) was used to diagnose the viral infections. About 70% of the samples (including wheat and oats) were found to be infected with PAV; 10% with RPV (oats only); and non with MAV. About 20% of the samples showing virus-like symptoms did not react with BYDV. This indicates that other cereal viruses may be commonly present in Louisiana.

MARYLAND

David J. Sammons and Robert J. Kratochvil

Production:

Interest in the production of oats in Maryland has been stimulated in recent years by rising prices and demand, and by news reports of short supplies in the United States. In response to this interest, spring oat varieties, commercial brands, and advanced breeding lines have been tested in recent years by the Maryland Agricultural Experiment Station, Department of Agronomy. In order to answer producers' questions about this crop and its potential in the Piedmont region of the state, this test is conducted at the Central Maryland Research and Education Center (Forage Farm) in Howard County. Entries in the test are selected each year to represent those that are generally available in Maryland and that are commonly grown in the state. In addition, promising new varieties, commercial brands, and advanced breeding lines are also tested to compare their performance to that of better known material.

Current farm production of oats occurs on only about 20,000 acres, but yields are generally good, and quality, at least in dry years such as 1988, is acceptable. Total state production of oats in 1988 was 884,000 bushels.

Production Environment:

Production of spring oats in 1988 was greatly enhanced by excellent environmental conditions, which permitted timely planting and good stand establishment, and which restricted disease development. A cool, wet period during April and early May favored excellent early vegetative growth. In late May, rainfall essentially ceased for the remainder of the season, but the spring oat crop was able to mature on soil moisture reserves, and it then dried drown quickly enabling timely harvest. The dry period from late May to July also inhibited disease development, which contributed to the high yields observed. Although temperatures were high during the grain filling and maturation period, physiological blasting did not occur in these tests prior to harvest.

Variety Test Results:

Spring oat performance data are summarized in the table which follows. Yields were excellent for all entries tested. Highest yield. (154.6 bu/acre) was obtained from the Illinois experimental line IL 80-2294. Among named varieties, Lang, Hamilton, and Larry all yielded over 140 bu/acre. Test weight for virtually all entries was good to excellent, with most in the range 32-35 lb/bu. Lodging was minimal for most entries, although Coker brand 820, Don, and Garry were observed to have substantially more lodging than other entries. Plant height at maturity for most test entries was close to 40", although three were notably short (Coker brand 820, Don, Pennlo), and two were unusually tall (Garry, Steele). All entries headed during the period between May 30 and June 6.

Average performance of spring oat entries at Clarksville, Maryland-1988.

Entry	Yield (bu/a)	Test weight (lbs/bu)	Lodging+ (0-9)	Height (in)	Date Headed	Origin
Centennial	135.2	31	1	42	May 31	Wisconsin
Coker brand 820	127.5	37	5	35	June 6	So. Carolina
Dal	97.9	31	2	40	May 31	Wisconsin
Don	133.1	35	5	36	June 4	Illinois
Garry	109.6	31	4	46	May 31	Wisconsin
Hamilton	146.1	32	0	41	June 1	Iowa
Hazel	133.1	33	1	39	June 2	Illinois
Lang	149.3	31	0	41	May 31	Illinois
Larry	141.6	32	1	40	June 1	Illinois
Noble	126.9	33	0	42	June 2	Indiana
Ogle	130.3	33	0	42	June 2	Illinois
Otee	120.3	32	1	42	June 1	Illinois
Pennlo	118.1	32	0	31	June 1	Pennsylvania
Porter	121.2	37	2	43	June 6	Indiana
Steele	113.1	37	1	45	June 6	No. Dakota
Webster	136.4	37	1	42	June 6	Iowa
*X-4872-2	134.5	34	0	42	June 3	Wisconsin
*IL 80-2294	154.6	33	4	41	June 2	Illinois
*IL 81-1882	143.3	33	0	39	June 2	Illinois
*IL 81-2570	116.4	30	0	39	May 30	Illinois
*IL 82-2070	125.1	34	0	37	June 3	Illinois
*IL 82-2154	91.2	33	1	39	June 2	Illinois
*IL 83-8022	121.9	33	2	39	June 2	Illinois
*IL 83-8037-1	133.6	33	0	38	June 2	Illinois
*IL 83-8518-1	133.9	34	0	39	June 3	Illinois
*IL 84-3098-1	114.2	30	1	38	May 30	Illinois

+Lodging based on a score of 0 to 9 where 0 = no lodging and 9 = flat

*Experimental breeding line
Conducted at: Central Maryland Research and Education Center - Forage Farm
Soil type: Manor silt loam
Date planted: March 11, 1988
Date harvested: July 14, 1988
Fertility: 33 lb N/acre, 100 lb P_2O_5/acre at planting
LSD (0.05) for yield = 21.4 bu/acre

MINNESOTA

D.D. Stuthman, H.W. Rines, R.D. Wilcoxson,
S.R. Simmons, L.L. Hardman, and K.J. Leonard

University of Minnesota and USDA-ARS

Production

Oat production in Minnesota in 1988 was about 25 million bushels, the smallest crop in 110 years. The acreage harvested for grain, only 750,000 acres, was one of the smallest in recorded history. The proportion of planted acreage harvested for grain (44%) is the second lowest ever recorded. The primary reason for the small fraction of the planted acreage being harvested for grain was an extended drought during much of the growing season. The lack of rainfall was pervasive throughout most of the state; however, in a few, relatively small areas, grain yields as high as 140 bushels/acre were reported.

Research in recurrent selection

The results from the 1988 evaluation (two locations of both row and hill plots) of the cycle five parents of our recurrent selection indicated an increase of 50+ percent in grain yield for the first five cycles. On a per cycle basis, the gain averages 10+ per cent each cycle and with a three-year cycle time, there is an average annual gain of 3.3 percent. For the first time, the gains measured in row plots were actually larger than those measured in hill plots. Previously, measured gains were always greater in hill plot evaluations, perhaps because all parental selection has been done with only hill plot evaluation. These yield gains were accompanied by undesirable changes in maturity, height, lodging, and kernel quality. Thus we are now addressing how best to correct these problems and move this germplasm back to more acceptable levels for these other traits. Yield evaluation of cycle five progeny will be initiated in the summer of 1990.

A formal release of the cycle four parents can be found elsewhere in this newsletter.

Personnel

Dr. Mark Farnham has completed his Ph.D. and is now in a postdoctoral position with Dr. Carroll Vance in our department. He is working on the genetic evaluation of the nitrogen fixation of forage legumes. His Ph.D. thesis research dealt with the morphological and genetic characterization of a peduncle extender gene from *Avena sterilis*. This gene(s) produces longer peduncles which in turn ensure that panicles will fully emerge from the boot, a requirement for a successful dwarf cultivar.

Dr. Don Lee joined our group as a postdoctoral working on the molecular genetics of lipoxygenase genes in oats. This new effort is being supported by The Quaker Oats Company and complements the research efforts in oat biotechnology of four graduate students also supported by Quaker.

Dr. Kurt Leonard has assumed the duties of director of the USDA Cereal Rust Laboratory. He is also responsible for the oat rust efforts and will manage our buckthorn nursery. Also joining the staff of the Rust Laboratory is Dr. Les Szabo who will work on the molecular biology of the rust organism of small grains including oats.

MISSOURI

A.L. McKendry, P. Rowoth, C. Hoenshell

Production: Oat production in Missouri in 1988 was severely affected by the drought. 120,000 acres were seeded with 40,000 acres harvested for seed, down 50,000 acres from 1987. The average state yield was 36 bu/a resulting in the production of 1.44 million bushels, less than half of the 1987 value. Spring moisture was adequate for planting but rainfall was very much below normal for the duration of the season and combined with high temperatures, resulted in severe yield reductions. Barley yellow dwarf virus continued to be a major concern, contributing significantly to the yield reduction experienced in 1988.

Breeding and Genetics: Conventional breeding procedures are being used to develop varieties with improved yield and test weight under the drought and heat stressed conditions prevalent in Missouri during the oat growing season. Efforts are also underway to improve tolerance to barley yellow dwarf virus in Missouri lines.

NEBRASKA

T.G. BERKE AND P.S. BAENZIGER
University of Nebraska

Harvested oat acreage in Nebraska was 300,000 acres in 1988, the lowest since 1881. Average yield per acre was 37 bushels. Dry weather in the spring of 1988 allowed early planting of oats throughout the state. The eastern half of the state got only scattered showers after planting, whereas the western half received adequate moisture to start the crop. High temperatures and dry conditions throughout the spring and early summer reduced yields and decreased the test weight of the grain. In outstate tests Ogle continued as the top yielding cultivar.

Professor August Dreier retired from the University of Nebraska on July 1, 1988. For many years he coordinated the planning and planting of the state oat variety tests. Lenis Nelson, former research agronomist at the High Plains Ag Laboratory in Sidney has taken over Professor Dreier's duties.

NEW YORK

Mark E. Sorrells and G. C. Bergstrom
Cornell University

<u>1988 Spring Oat Production</u>: The 1988 oat crop for New York State averaged 52 b/a on 145 thousand acres harvested, 8 b/a lower yield and 55 thousand less acres than for 1987. The yield reduction was probably due to a dryer than average March, April, and June. Ogle and Porter continue to dominate the acreage planted.

<u>Cultivar Development</u>: In 1988, Ed Souza completed a backcrossing program to transfer white hull color into Ogle. Approximately 50 backcross 4, F3 families were field grown and evaluated in 1988. We harvested 110 kg of backcross derived lines that were similar to Ogle except for the hull color. The kernel color of this backcross line is grey and is similar to Porter. We have tentatively decided to release this as a cultivar pending further evaluation.

<u>Genetic Relationships Among Avena Sterilis Accessions:</u> In collaboration with Dr. Paul Murphy, we have begun a project to assess the genetic variability in *Avena sterilis* accessions in the National Small Grains Collection (NSGC). Dr. Murphy has been using isozymes to assess genetic relationships and reported much progress at the Oat Biotech III conference. We recently began assessment of the same accessions using RFLPs. Our objectives are to determine the genetic relationship among *A. sterilis* accessions randomly sampled from the NSGC and to compare results from RFLP analysis with results from morphological traits and isozyme analysis. From a Pst I digest we currently have 850 transformants and about 400 clones have been minipreped. Mean insert size is 1.5 kb and approximately, 25% of the clones contain inserts that are moderately repeated. We are currently screening these clones on survey genotypes to determine actual copy number and polymorphism. Thus far, Ogle and Brooks have been polymorphic for most of the single copy clones. We currently have a single seed descent population from the Ogle/ Brooks cross at the F5 generation. If anyone would like to evaluate this population for other characteristics, we would be glad to provide seed. Our goal is to accumulate as much information as possible on this population so that linkages between DNA markers and agronomic or other traits can be established. We have already scored the population for red seedling leaf and sheath pubescence.

<u>Coefficients of Parentage for North American Oat Cultivars</u> Dr. Souza and I have published a bulletin containing pedigrees and coefficients of parentage for about 250 North American oat cultivars. We have sent out this bulletin to several people already but we can provide a copy to anyone that did not receive one.

<u>Publications</u>:

Souza, E. J., and M. E. Sorrells. 1988. Mass selection for improved groat percentage in oats. Crop Sci. 28:618-623.

Souza, E. and M. E. Sorrells. 1988. Coefficients of Parentage for North American Oat Cultivars released from 1951 to 1986. Search: Agriculture. Ithaca, NY: Cornell Univ. Agric.Exp. Sta. No. 33, 102 pp.

Souza, E. , and M. E. Sorrells. 1989. Pedigree analysis of North American oat cultivars released from 1951 to 1985. Crop Sci. 29: In press.

Souza, E. , and M. E. Sorrells. 1988. Inheritance and frequency of a null allele for diaphorase activity in North American oat cultivars. J. Hered. Accepted

Souza, E. , and M. E. Sorrells. 1988. Inheritance and distribution of variation at four avenin loci in North American oat cultivars. J. Hered. Accepted

NORTH CAROLINA

Ronald E. Jarrett, Steve Leath, and Paul Murphy
North Carolina State University

Production and Growing Season

There were 100,000 acres of oats planted in North Carolina in the 1987-88 season. Forty-five percent of the acreage (45,000) was grown for cover crops, hay, silage, etc., while fifty-five percent (55,000) was harvested for grain. The 1987-88 growing season was excellent for oat production. Precipitation was adequate throughout the season, and April and May were cool and slightly dry. Disease was present but was not a major problem. Production was 3.58 million bushels, about the same as 1987 although the acreage harvested was 8.4% less than in 1987. The state average yield per acre was 65 bushels (a 10% increase over the previous year). The value of the 1988 grain production was $5.72 million (a 15.3% increase over 1987), while the total value of the entire crop was $10.4 million.

The interest in oats is increasing primarily because of demands for good quality oats for recreational and pleasure horses, and because of the increased interest in oats for human consumption as a healthy aid: oat bran, low cholesterol, etc. Thus, the acreage of oats is expected to increase gradually.

Pathology

A study on the possible predisposition of oats to winter injury resulting from fall infections by root- and crown-infecting fungi was continued. Metalaxyl treatments resulted in taller plants and increased numbers of tillers in oats planted at a Piedmont location. All plants died of cold damge at a mountain location. A number of fungal isolates were recovered from roots and crowns of stunted plants in early spring. The predominant fungi were *Pythium* spp. and greenhouse pathogenicity tests are being conducted to assess the aggressiveness of the isolates. The study was redesigned slightly and replanted fall 1988.

Heritability of oat mosaic virus resistance

Detailed knowledge about the heritability of oat mosaic virus (OMV) resistance would assist breeders in planning strategy for incorporation of resistance into new cultivars. One hundred $F_{2:3}$ and $F_{2:4}$ lines derived from two double cross populations whose parents had a range of OMV resistance were evaluated in the 1987-88 season at Clayton and Rowan, North Carolina in six replicate hill plot experiments. Narrow sense heritability estimates ranged from 0.51 to 0.62 based on entry means over two environments. The parent-offspring regression coefficient was 0.38. Realized heritability was 0.85, based on two locations, and was somewhat lower for individual locations. The moderate to high heritability estimates found suggest that considerable progress may be expected from selection for OMV resistance in segregating populations.

Estimating Genetic Diversity in the Avena sterilis L. Collection Utilizing Enzyme Polymorphisms

Much of our effort over the past twelve months went into determination of enzyme systems that would be useful (i.e., polymorphic and repeatable) in providing us with information on the distribution and stratification of genetic diversity among Avena accessions in the U.S. National Small Grains Collection. Preliminary results were obtained from data on 11 polymorphic enzyme systems for 180 A. sterilis accessions from Algeria, Morocco, Ethiopia, Israel, Lebannon, Syria, Iran, Iraq, and 50 oat (A. sativa L.) cultivars from North America. A mean of 4.9 genotypes per enzyme was observed in A. sterilis versus a mean of 2.76 in A. sativa; 46% of the genotypes observed were unique to A. sterilis. Overall, mean Probability of Genetic Identity between the wild and cultivated species was 0.94, indicative of their subspecific to conspecific status. The probability of finding a Unique Genotype was 0.06 and 0.01 in the wild and cultivated species, respectively. Forty-six percent of the unique genotypes occurred in Lebanese accessions while only 8% occurred in Algerian accessions. Principal component analysis also indicated close association between Algerian accessions and cultivars. Work is continuing on the screening of accessions in the collection and genetic analysis of variant types.

Publications

Cox, T. S., J. P. Murphy, and M. M. Goodman. 1988. The contribution of exotic germplasm to American agriculture. in: Seeds and Sovereignty: Debate Over the Use and Control of Plant Genetic Resources. Jack Kloppenburg (ed.), Duke Univ. Press, Durham, NC. pp. 114-144.

Phillips, T. D., and J. P. Murphy. 1988. Estimates of Genetic Identity Among Samples of Avena sterilis L. and A. sativa L. from the National Small Grains Collection. Intl. Symp. on Population Genetics and Germplasm Resources in Crop Improvement, Davis, CA. (Abstr.)

Uhr, D. 1989. Heritability and Response to Selection for Resistance to Oat Soilborne Mosaic Virus. M.S. Thesis. Crop Science Department, North Carolina State University, Raleigh.

Personnel

Dr. Kira L. Bowen left her post-doctoral position with Dr. Leath to accept a faculty position at Auburn University. Dr. Kate L. Everts, Ph.D., Michigan State University, has accepted a post-doctoral position in Dr. Leath's small grain pathology program. David Uhr completed the requirements for his Master of Science degree with Dr. Murphy's breeding program and is currently working towards a Ph.D. degree with Dr. Goodman in the Crop Science Department, NCSU.

NORTH DAKOTA

Michael S. McMullen

The 1988 growing season was characterized by extreme drought and high temperatures over most of the state of North Dakota. These conditions were devastating to both commercial oat production and oat field research. Grain yield and test weight were much below average in most areas.

Production

The USDA National Agricultural Statistics Service reported 1.1 million arcers of oats planted in North Dakota in 1988 which was a 50,000 acre increase relative to 1987. The severe weather conditions caused a shortage of forages for cattle and reduced the yield potential of oats planted for grain resulting in only 0.4 million acres harvested for grain. This represents a 0.3 million acre decrease relative to 1987. The average yield per harvested acre was 18 bushels resulting in only 7.2 million bushels of production in 1988, far short of the previous ten year annual average production of 44.6 million bushels.

Diseases

The dry conditions did not allow development of fungal diseases and very little naturally occurring stem or crown rust was observed. Barley yellow dwarf virus symptoms were apparent and widespread early in the season, but other environmental stresses overwhelmed the expression of virus symptoms as the season progressed.

Breeding

'Valley' was grown on 2,200 acres for registered seed production. Decreased yields and loss of some fields intended for registered production will somewhat reduce the availability of Valley to certified growers in 1989. ND810104 (RL3038/Goodland//Ogle) was increased in anticipation of release for 1989, but drought and a late season hail storm reduced production so that not enough seed was available for a release. ND810104 will be increased again in 1989 and is planned to be released for 1990 production.

Research

The development of 'Steele' involved seedling testing with critical crown rust races to detect the presence of Pc-38 and Pc-39 in plants of a segregating population derived from a series of crosses in which a germplasm line, RL3038, contributed Pc-38 and Pc-39. RL3038 was provided by workers at the Agriculture Canada Research Station in Winnipeg. The Winnipeg group developed 'Dumont', which possesses Pc-38 and Pc-39. Unexpected segregation for crown rust resistance conditioned by Pc-38 was observed in the progeny of Steele/Dumont hybrids. Studies by a graduate student, Gene Leach, involving backcrossing of resistant derivatives of Steele/Dumont crosses to both Steele and Dumont suggest the chromosomal location of Pc-38 is different in Steele than in Dumont. Derivatives have been identified genetically which have Pc-38 at both the Steele and the Dumont loci resulting in plants with four doses of Pc-38 in the homozygous condition which will be useful for evaluation of dosage effects of a rust resistance gene on expression of resistance. Cytological observations of PMC's of Steele/Dumont F_1's and crosses of lines with Pc-38 in the Steele position and the Dumont position are consistent with the hypothesis that a change in position of the Pc-38 locus is due to a recripocal translocation. The occurrence of Pc-38 in Steele at a locus different from that of Dumont may allow combining Pc-38 with Pc-63 which was found by the Winnipeg group to be either allelic or tightly linked with Pc-38. Work is underway to combine the two alleles in the homozygous condition in the same breeding line.

OHIO

O.A.R.D.C./O.S.U.
R.W. Gooding and H.N. Lafever

Oat Production and Growing Conditions in 1988

Drought conditions severely affected the oat crop in Ohio in 1988. According to the Ohio Agricultural Statistics Service, statewide average yields per acre were 36 percent less in 1988 than in 1987. Average yields of 45 bushels per acre coupled with only 200,000 acres harvested, resulted in a new record low for oat production in Ohio of 9 million bushels, a drop of over 48 percent from 1987 levels. Current federal farm programs continue to keep oat production in check. Even though the price received for oats in Ohio increased by approximately 167 percent from July, 1987 to July, 1988, oat acres harvested dropped by 20 percent making 1988 the second lowest year on record for acres of oats harvested.

Cold, wet soil conditions delayed oat planting in Ohio. By the 1st of May, only 25 percent of the oat crop had emerged compared to 66 percent in 1987. By the middle of May, oat planting was essentially completed but crop development was retarded because of dry soils and slow germination. By late May, it was evident that drought was stressing the crop. Oats began to head in Ohio during the last week of May, but the majority of the crop was not reported to be in head until the third week of June, approximately 10 days later than normal. After anthesis, an acute lack of moisture and abnormally high temperatures were severely suppressing the yield potential of the oat crop in Ohio. For instance, at our Northwestern Branch experiment station near Custar, Ohio, just over an inch of rain fell on the 3rd of April. From that date until crop maturity, only 2.5 additional inches of precipitation accumulated, most in increments of less than .25 inches, 8.7 inches below normal for the period. In addition, weather records show a total of 15 days in which the temperature rose above 95°F. Six of those days, had temperatures in excess of 100°F. A high temperature of 106°F was recorded on June 25th and three consecutive days of over 100°F temperatures were recorded on July 5-7, 1988.

At harvest, the Ohio Agricultural Statistics Service rated 65 percent of the Ohio oat crop either poor or very poor with 29 percent fair and the remaining 6 percent good.

Breeding Program

Overall, drought severely affected 1988 performance in our breeding nurseries. The spread between varieties and test lines was greatly reduced and rankings based on yield and test weight appeared changed compared to a more normal year. Nevertheless, the oat breeding effort in Ohio continues to expand. From its inception in 1984, the number of plots evaluated has increased by over 1,000 percent. We feel that progress to date, in the context of plant breeding time tables , has been very rapid. We expect to evaluate over 9,400 plots in 1989, an increase of more than 16 percent above 1988 levels. New nurseries in 1989 will include a second advanced rod row nursery (ARR) and a preliminary drilled plot yield test (Prelim DPYT). Both of these nurseries will test the most elite material in the program. The new ARR nursery will be conducted at two locations in Ohio and the Prelim DPYT will be grown at Wooster, primarily as a seed increase nursery but also with the objective of acquiring valuable data from larger drilled plots. A total of 184 elite test lines will be evaluated in replicated micro-plot nurseries (6-10 ft. rows per plot planted on 6 inch centers). Forty-four of these elite lines will be in Advanced Rod Row evaluation nurseries planted at 2 or 3 locations in from 4 to 6 replicates depending on location.

Equipment and facility upgrades in 1988 included the acquisition of a new oat seed processing and storage facility as well as the construction of several hundred dryer boxes used in the conditioning and storage of samples. Modifications were also made to our swift current plot seeder to make it more suitable for sowing oat nurseries.

Several lines out of the Ohio program showed promise in 1987 and 1988 and four of these lines will be entered in the Uniform Oat Performance Nurseries in 1989 (the first lines out of this program to reach this level). OH1006 and OH1014 will be entered in the UMOPN and OH1011 and OH1012 will be entered in the UEOPN.

OREGON

Russ Karow, Patrick Hayes, Randy Dovel
Crop Science Department, Oregon State University

Approximately 75,350 acres of oats were harvested for grain in 1988, an increase of nearly 10,000 acres over 1987. State yield average for 1988 is projected to be 105 bushels per acre - a state record. Approximately 70% of the 1988 oat crop is projected to be sold off-farm.

Acreage increase is attributed to renewed national interest in oats, to farm program provisions, to poor planting conditions for winter cereals in the fall of 1987, and to the presence of an oat milling facility in Eugene, Oregon. For the first time in several years, small acreages of both winter and spring oats were planted under dryland conditions in eastern Oregon. We attribute the record yield to unusual late spring and summer rains across the state.

Cayuse, Monida, Otana and Border are the dominant spring cultivars, while grey winter, Walken, and Amity the dominant fall seeded cultivars. Several short statured lines out of Daryl Wesenberg's program in Idaho look promising.

Western regional spring oat trials and trials involving commonly grown varieties, seeding rates and nitrogen rates are currently being conducted by Russ Karow near Corvallis and in Klamath Falls by Randy Dovel. The purpose of these trials is to assess potential for improving yield, standability and quality of oats. Winter oat trial work is coordinated by Pat Hayes. An increased effort to evaluate introduced winter lines under western Oregon conditions is also anticipated.

There is no breeding work being done in Oregon at this time nor is such effort anticipated in the near future. Crater, an improved grey winter type released in 1956 by Oregon State University, is being increased for re-release.

PENNSYLVANIA

The USDA oat improvement position at University Park, Pa., was filled by David Livingston in June 1988. After consultation with H.G. Marshall and ARS personnel, it was decided that the spring oat breeding program would be continued and the winter oat project would take a more basic approach. The relationship of carbohydrates to winter oat survival in controlled freezing tests, and how this relationship might be affected by BYDV infection is being studied. One spring line (PA8393-1500), a white oat with yield similar to Ogle in Pennsylvania, and similar to Ogle in maturity and lodging resistance, will probably be released in fall 1989. Evaluation will continue on other candidates for possible release (PA8494-4099 and PA8196-1334). Four hulless composites with at least four cycles of selection for high specific gravity seed weight will be released in spring 1989. In addition, three hulled composite populations with a high frequency of genes for semidwarf plant height and selection pressure for high specific gravity will also be released this spring.

SOUTH DAKOTA

D. L. Reeves and Lon Hall

Production: Our oat production was the lowest since 1936 with 20,000,000 bushels produced. Planted acreage (1,400,000 A.) was the same as the previous year but production was down 62%. We had two primary problems, first was the very low rainfall especially in our small-grain growing regions. Many wheat and oat fields in the north central part of the state were only about one foot tall and had very sparse stands. Our second problem was the severe barley yellow dwarf outbreak in the eastern part of the state which is our major oat production region. Our hot spring temperatures combined to force early plant development and good aphid conditions.

Varieties: The 1988 survey listed have the following 8 varieties and their percentage of the acreage:

Burnett	39.0
Kelly	12.5
Moore	5.8
Nodaway 70	5.8
Hytest	5.1
Steele	4.9
Don	3.3
Porter	2.0

Other varieties named were: Benson, Chief, Lancer, Lyon, Noble and Wright. However, 21.6% was listed as planted to all other and unknown varieties. Burnett is still planted on about 60% of the acreage in the northwest, north central, west central and south central districts. Seed dealers feel the acreage of Burnett is less than indicated. They believe many farmers who don't know their oat variety call it Burnett because they know the name and feel it may help to sell it due to its reputation for high quality grain.

A large increase in the acreage of Don is expected in 1989 due to its resistance to BYDV. Don has always performed well here, but the relative performance in 1988 was much better due to its BYDV resistance being noticeably better than most other varieties. Our major surprise was the poor performance of Steele whioh had done very well in previous years. The heat or dry weather are suggested as the probable causes of its poor production. If you need a new BYDV susceptible variety, let me recommend Trucker, the variety we released in 1988.

Research: The importance of sprayer adjustment and proper application was evident in 1988. 2,4-D amine at the 1 lb. rate reduced the yield of Lancer by 29% while Banvel (.25 lb) + MCPA amine (.5 lb) gave an 18% reduction. Both also reduced test weight about 10%. To avoid such consequences, adjust the sprayer properly and don't overlap between passes.

Paul Gaspar completed his Ph.D. and is now an agronomist with Pioneer in eastern Nebraska. He found adding chloride sometimes increased yield and 1000 kernel weight of oats. Early in the growing season N and Cl were antagonistic. Adding Cl reduced lodging but didn't affect crown rust, leaf water content or potential, tiller number or stomatal conductance.

WISCONSIN

R. A. Forsberg, M. A. Brinkman, R. D. Duerst. J. B. Stevens
E. S. Oplinger, D. M. Peterson, C. A. Henson, H. L. Shands, and
K. D. Gilchrist (Agronomy) and A. H. Ellingboe (Plant Pathology)

Production: Wisconsin farmers planted 1,200,000 acres of oats in 1988 and harvested 580,000 acres for grain and straw. The statewide grain yield average was estimated at 40 bu/a, down 14 bu/a from 1987 and 22 bu/a lower than the 1986 average. The yield reduction was caused by unusually warm temperatures and record-setting drought conditions which were prevalent throughout much of the 1988 growing season. The hot, dry conditions resulted in early heading, short straw, and virtually no diseases. Most of the non-grain oat acreage was harvested as forage to compensate for substantial reductions in alfalfa yield that occurred on many dairy farms.

Varieties: Acreages of oats grown by Certified Seed growers indicate that Ogle and Hazel were the leading varieties in Wisconsin in 1988, with substantial acreages of Centennial, Steele, Porter, and Webster also grown. On the basis of yield trial results it appears that Ogle and X4872-2, which was released in February, 1989 and named Horicon, had better tolerance to the hot, dry conditions than all other varieties. Both produced grain yields as high as 88 bu/a, which is remarkable considering the severity of the season. Horicon was selected from an X3530-47/Ogle cross and is midseason in maturity. A description of Horicon appears in the new varieties section of this newsletter.

A major increase of X4872-1-3, a sister line of Horicon, will be grown in 1989 with intent to release in 1990. This is an early selection that performed quite well in the 1988 Uniform Early Oat Performance Nursery and has been impressive in tests throughout Wisconsin in recent years. It has stiff straw and good crown rust resistance.

Forage oat selection SN404 continued to perform well in 1988 forage oat evaluations, but a 20-acre increase field did not produce enough seed to warrant releasing it in 1989. SN404 is a very late header that appears to have difficulty producing seed in drouthy conditions. It will be increased on a larger scale in 1989 and watched closely to assess its seed producing capabilities.

Research: Mr. Ronald A. Bunch completed his Ph.D. studies on groat and hull development and relationships between groat percentage and productivity traits in cultivated oats (*Avena sativa* L.). In the first study, groats and hulls from six oat genotypes were sampled at 2- to 4-day intervals from anthesis through maturity in 1986 and 1987 to determine post anthesis growth patterns, rates, and durations of groats and hulls and to determine the relationships of these traits with groat weight, hull weight, and groat percentage. Cubic polynomial curves fit the groat dry weight data and quadratic curves fit the post anthesis hull dry weights. Growth duration was not related to groat percentage. Absolute growth rates were positively related to groat and hull dry weights. Relative growth rates were generally not significantly different among genotypes. Variation for temperature and rainfall had a significant influence on grain growth and development, groat and hull weight, and groat percentage.

A second study was designed to examine the relationships of groat percentage with kernel weight, grain weight per tiller, and biomass per tiller and to determine the inheritance of these traits in two oat crosses between parents divergent for these traits. [Cross 1 = X4614-1 x X5243; Cross 2 = X4614 x X3962-7]. The F_2, F_3, F_4, and F_5 progeny values generally fell within the range of the two parents of each cross for all traits except grain weight per tiller, which showed substantial positive transgressive segregation. Most heritability estimates by parent-offspring regression were intermediate, with an overall range of 0.04 to 0.79. Most of the 36 intra- and inter-generation/location correlations between groat percentage and kernel weight for Cross 1 and 33% of these correlations for Cross 2 were significantly negative. Less than 50% of the correlations for Cross 1 and none for Cross 2 were significantly negative for groat percentage with grain weight and biomass per tiller. Families were identified from both crosses with both high groat percentage and grain weight per tiller.

In a third study, eighteen genotypes were grown in two locations in 1987 to study the relationships between large plot measurements and single plant measurements. Groat percentage, primary kernel weight, and average kernel weight measured on individual plants were highly correlated with the same traits measured on large plots. No productivity trait measured on individual plants was correlated with grain yield from large plots.

Mr. M. A. Moustafa continued his studies of abnormal segregation for crown rust resistance in F_2 and F_3 progenies from crosses between resistant translocation lines (N569, N770, and DC5 1789) and Avena sativa cultivars. Some crosses had normal chromosome pairing of 21 bivalents at metaphase I. In other crosses, a considerable percentage of cells had different pairing arrangements such as 19 II + 1 IV, 20 II + 2 I, or 19 II + 1 III + 1 I.

In addition to the variable chromosome pairing, the following two observations may help to explain the abnormal segregation ratios obtained:

1. In metaphase I, one II, two II, or more, were positioned away from the cell plate. Chromosomes of these bivalents are likely to be lost after chromosome separation at anaphase I. Some chromosomes were positioned away from the major chromosome group at anaphase I. The resulting chromosome loss may include that chromosome(s) carrying gene(s) for resistance to crown rust.

2. In anaphase I, considerable abnormal chromosome separation was observed. These abnormalities included chromosome lagging, bridges, or both. Number of lagging chromosomes varied from one to five. Number of bridges varied from one to 12 per cell. These abnormalities in chromosome separation during anaphase may lead to the loss of chromosome(s) carrying gene(s) for resistance to crown rust.

Percentages of stained (normal) pollen in the translocation lines and in F_2 populations ranged from 94 to 99%, indicating that poor pollen development is not a cause of the IR:15 abnormal segregation ratios. The abnormal chromosome pairing and subsequent chromosome loss are more likely causes.

Mr. Louis Chapko is evaluating the relationship between panicle weight and grain yield in oats for his Ph.D. research. The intent is to use panicle weight from early generation head rows to assist in identifying high yielding oat genotypes in later generations. Two crosses, ND810104/Ogle and QR130-1/Ogle, are being evaluated. Ogle and ND810104 are high in panicle weight, while QR130-1 is low. Five hundred F_2 plants were evaluated in each cross in 1987 and 140 F_3 progeny rows from each cross were grown in two replicates at Madison in 1988. Correlations in the F_2 generation were high for the QR130-1/Ogle population, which indicates that plants having high grain yield can be identified by high panicle weight. However, all correlations between generations for the two populations were low, indicating that selection for improved grain yield or for altering panicle weight may be difficult in early generations. The two populations are being grown in a winter nursery in New Zealand for generation advancement. The F_4 genotypes will produce F_5 seed that will be planted in 1989.

Forage yield and quality evaluations in oats, barley, and spring triticale are continuing at Wisconsin. Our results indicate that oats are preferable to barley when harvested at early heading because oats tend to be 5 to 9 percentage points lower in NDF than barley. Low NDF is desirable because it is associated with greater forage intake by ruminant livestock. Several spring triticale varieties have posted good forage yield and quality scores in our tests. With respect to forage yield and quality, it appears that the best oat and spring triticale varieties are comparable. Evaluations of oat and spring triticale forage characteristics will be continued in 1989.

There were 175 pure lines and 150 segregating populations in the Quaker nurseries grown in South America in 1988. M. E. McDaniel (Texas A and M University), D. C. Burnette (Quaker Oats Company) and M. A. Brinkman visited nurseries in Brazil, Argentina, and Chile in November, 1988. Except in Chile, the nurseries were not as productive in 1988 as in 1987, due largely to dry conditions which prevailed in much of Brazil and Argentina during oat planting. Much of the oat growing area of Argentina received only 0.1 inch of rain from March through September. Consequently, plant height was very short and grain yield potential appeared to be quite limited. The Quaker group estimated that oat grain yields in the Tres Arroyos area of Argentina would be 30 to 40% of what they were in 1987. Oat growing conditions in Chile were favorable, and yields appeared to be high except where BYDV was prevalent.

UTAH

R.S. Albrechtsen

Utah State University

Production. Utah's 1988 planted oat acreage was up slightly, but that harvested for grain was equal to that of the previous year. Yield per acre was above that of 1987, resulting in a higher total production. Roughly half of the planted acreage is normally harvest for silage or is grazed.

Losses from diseases are generally small. Insects are becoming more prevalent, with infestations of the Cereal Leaf Beetle a few years ago and the appearance of the Russian Wheat Aphid in 1988.

Oat Program. Because of our small oat acreage, we do not carry on an oat breeding program. Improved cultivars from other programs are identified from the uniform Northwestern States Oat Nursery which we continue to grow. "Monida" consistently performs well in our tests.

ADAM

F. Machan, J. Cervenka, F. Benes

'Adam' was bred in Krukanice Breeding Station by crossing of naked cultivars 'NOS Nackt' x 'Vicar' CAN 827. Selected plants were further crossed to 'Diadem' and subsequently to 'Bento' from the Netherlands. Adam was evaluated in the State Cultivar Tests as KR-3009.

It is an early (1 day later than 'Veles'), naked cultivar. Tillering is moderate and upright. Plant height is medium to relatively tall (1.25 - 1.35 m). Lodging resistance is good. Leaf color is green with a bluish shade, leaves are without hairs or only slightly pubescent, twisting intensity is low to medium ($90-180^{o}$), leaf ligule is large, colorless to slightly colored, with a serrated edge. The panicle is straight, medium long (16-18 cm), with medium number of florets. The husks have a light yellow color at ripening.

Kernels are awnless. Hectolitre weight is 58-65 kg, 1000 grain weight is 24-27 g. Proportion of husked grains is 1-3%, 1/3 of these being grains with a fixed husk. Crude protein content varies in the range of 14-16%, lipid content is 6-8%, and fiber content is below 5%.

Adam has medium resistance to _Pyrenophora avenae_ and to _Puccinia coronifera_.

The highest grain yields are achieved in intensively managed conditions. The grain yield is lower by 30-45% in comparison with productive husked cultivars. Due to the fact that 1000 grain weight is higher by 2-4 g than that of hulled husked oats, the efficiency of Adam in oat flakes production is substantially higher.

Proper combine adjustment at harvest is very important with respect to low 1000 grain weight. There is a danger of loss of the most valuable grain proportion in the case of a stronger wind at cleaning. Threshing must be performed at low grain moisture content (below 13%), in order to prevent losses due to improper threshing. Grain with higher moisture content must be dried to prevent mold growth.

No special production practices are necessary. A sowing rate of 5 mil. germinable grains per ha is recommended. It responds positively to a good forecrop. Nitrogen rate should be 70-90 kg N/ha. It is not necessary to apply morphoregulators to prevent lodging.

Economic and technological characteristics of oat-varieties Zlatak and Adam CSSR - State trials - 1987-1988.

Characteristics		Zlatak husked	Adam naked
Plant height	cm	112	130
Vegetation period	days	118	120
Lodging resistance	9-1	4	5
Number of panicles $.m^{-2}$		612	468
Number of grains in panicle		31	32
Weight of 1000 grains	g	34.0	27.7
Helminthosporium gram.	9-1	6	6-7
Crude protein	%	11.89	15.20
% of husked grains		100	3.2
Grain yield	$t.ha^{-1}$	6.22	3.98

BUNDEL JAI - 822

R. N. Choubey and S. K. Gupta

'Bundel Jai-822', a spring oat variety, was developed at the Indian Grassland and Fodder Research Institute, Jhansi. It was derived from the cross 4268 x Indio made at G. B. Pant University of Agriculture and Technology, Pantnagar. Bulk seeds from the F_2 generation were received at Jhansi in 1977. The material was advanced by pedigree method and final selection was made in 1982-83 from F_7 progenies. Bundel Jai-822 was tested as 'JHO-822' for adaptability in the initial and final evaluation trials of the All India Coordinated Project for Research on Forage Crops from 1983-84 to 1986-87. It was found to be suitable for the Central Zone of India under multicut management system.

Bundel Jai-822 is medium tall (100-110 cm). The lemmas are cream and non-hairy. Awns are usually absent but some florets may have very weak awns. It has erect growth habit. The panicles are equilateral and loose. The seeds do not shatter at maturity. In Jhansi conditions, it takes 95 to 100 days from seeding to flowering and 125 to 130 days from seeding to maturity. It possesses high field resistance to all major diseases and insect pests. It also posesses resistance to all stored grain pests.

Bundel Jai-822 has high initial growth vigor and is responsive to fertilizer application. It has very high regeneration ability after cutting when sown in the month of October. The forage of this variety is of high quality with 10.3 percent crude protein and high leaf:stem ratio.

JHO-822 was recommended for release during the group meeting of the All India Coordinated Research Project on Forage Crops held at Jhansi in September, 1987.

It is named as Bundel Jai-822 after the region of Bundel Khand in which the main campus of the Indian Grassland and Fodder Research Institute is situated. The breeder seed and nucleus seed of this variety will be maintained by the Seed Technology Division and Plant Improvement Division of this Institute, respectively.

DALYUP

Robyn McLean

Dalyup is an early-mid season oat released by the Western Australian Department of Agriculture in 1988. It was selected from the cross OT207/Swan//Moregrain/West made in 1976. Dalyup is a dwarf oat carrying the dwarfing gene DW6 from the Canadian parent OT207. Dalyup was released as a grain oat for the medium and southern high rainfall areas of Western Australia where it outyields all other cultivars.

Dalyup flowers and matures at similar times to the dwarf cultivar Echidna, and is of similar height. It has excellent straw strength and shedding resistance.

Regional trials in Western Australia from 1985-1987 indicate that Dalyup outyields cultivars Echidna and Mortlock by 5% and 15% respectively. In particular Dalyup further outyields these cultivars when sown early, or on sandy soils. Dalyup performed well in the Australian Interstate Oat Variety Trials in 1987, being ranked second overall.

Compared with Echidna, Dalyup has slightly plumper grain, slightly higher protein content, similar hectolitre weight, but lower groat percentage.

Dalyup is resistant to all Australian races of stem rust. It is susceptible to crown rust, septoria avenae leaf blotch and barley yellow dwarf virus.

HAY

Robyn McLean

Hay is an early-mid season oat released by the Western Australian Department of Agriculture in 1988. It was selected from the cross OT207/Swan made in 1975. Hay is a dwarf oat carrying the dwarfing gene DW6 from the Canadian parent OT207. Hay was released as a hay oat for the gravelly loam soils of the southern and south central high rainfall zones of Western Australia.

Hay flowers and matures at similar times to the dwarf oat Echidna. Although Hay is a dwarf oat it is considerably taller than Echidna, its average height in trials being 74 cms compared with 57 cms for Echidna. Hay has excellent straw strength and shedding resistance.

In the southern high rainfall areas of Western Australia Hay has outyielded all current grain and hay cultivars for hay yield. Hay does not outyield currently recommended cultivars for grain yield, yielding 10% less than Echidna, so was released as a hay cultivar only.

Quality tests indicate Hay has good hay digestibility and protein content. The grain quality of Hay is poor, being lower in hectolitre weight, groat percentage and percentage of plump grain than most commercial cultivars.

Hay is susceptible to stem rust, crown rust and septoria avenae leaf blotch, and has moderate resistance to barley yellow dwarf virus.

HORICON OATS

R. A. Forsberg and M. A. Brinkman

Horicon is a new, midseason, high yielding oat variety developed by workers at the University of Wisconsin-Madison. Tested as Wisconsin selection X4872-2, seed has been released by the Wisconsin Agricultural Experiment Station to Certified Seed growers, and Certified Seed will be available for general farm production in 1990. Horicon is the name of a large nature preserve in east-central Wisconsin widely known as a resting area for migrating geese.

The pedigree of Horicon is:

Holden/4,Irr./Garland/2/6x-amphiploid/2*C.I.6936/3/Garland/5/Froker/6/Ogle

The final cross, X3530-47 x Ogle, was made in 1978. Yield testing of Horicon began at Madison in 1983. It has been evaluated statewide since 1984 and it was an entry in the USDA multiple-state Uniform Midseason Oat Performance Nursery in 1987 and 1988.

Horicon is midseason in maturity, heading about a day later than Ogle and a day earlier than Hazel. In Wisconsin tests for the 4-year period 1985-1988, grain yield averages for Horicon were exceeded only by Hazel in the Arlington Drill Plots (94.0 vs 94.6 bu/a) and only by Ogle at the Wisconsin Agricultural Research Station (70.6 vs 73.3 bu/a). Horicon has wide adaptation. In 1988, it ranked first for grain yield in the Minnesota-North Dakota-South Dakota Tri-State Test, and it ranked 6th of 36 in the USDA Uniform Midseason Test (15 states, 21 locations). It ranked 4th or better in one or more tests in Iowa, Illinois, Michigan, Ohio, Minnesota, South Dakota, and Nebraska.

Horicon has tan, florescent kernels, high groat percentage and average test weight. It has good resistance to crown (leaf) rust, and it has demonstrated moderately good resistance to Wisconsin smut races in artificial tests. Horicon has received intermediate (good) readings for reaction to the Barley Yellow Dwarf Virus in Illinois tests, and it showed good to excellent tolerance under severe natural infection in the 1986 Madison Nursery. Horicon has good straw strength, with snap-back (stiffness) equal to that of Hazel and Ogle.

An application for Plant Variety Protection has been submitted for Horicon oats.

KALGAN

Robyn McLean

Kalgan is a midseason oat released by the Western Australian Department of Agriculture in 1988. It was selected from the cross OT207/Swan made in 1975. Kalgan is a dwarf oat carrying the dwarfing gene DW6 from the Canadian parent OT207. Kalgan was released as a dual purpose hay/grain oat for the gravelly loam soils of the southern and south central high rainfall zones of Western Australia.

Kalgan flowers and matures two days later than Echidna. Although Kalgan is a dwarf oat it is taller than Echidna. Its average height in trials was 69cm, compared with 57cm for Echidna. Kalgan has excellent straw strength and shedding resistance.

Kalgan has similar grain yield to Echidna, but a substantial hay yield advantage. It has superior grain yield to other cultivars such as Swan and Winjardie which are the most commonly used cultivars for hay production, and similar hay yields to these cultivars. Kalgan is being released as a dual purpose hay/grain oat because of its superior overall hay and grain yields, with the additional advantage of straw strength and shedding resistance. It should fit in well with farming management in which decisions regarding proportions of the oat crop which will be cut for hay, or left for grain are often made after seeding.

Quality tests indicate Kalgan has good hay digestibility and protein content. Compared with Echidna, Kalgan has slightly higher grain protein content, similar hectolitre weight and groat percentage, and slightly thinner grain.

Kalgan is susceptible to stem and crown rusts and moderately resistant to septoria avenae leaf blotch and barley yellow dwarf virus.

MARION OATS: THE NEW AND THE OLD CULTIVARS

J.P. Dubuc and A. Comeau

In 1985, an oat cultivar tested as Q.O. 186.10 was registered in Canada under the name Marion. A previous Iowa cultivar existed under that name but it is out of commercial production. In 1988, Canadian Marion has attracted quite a lot of attention worldwide when Gary Fulcher, from Plant Research Center, Ottawa, reported its high beta glucan content which is considered desirable in oats for human food. We would like to pinpoint other characteristics of this new cultivar. It has the pedigree:

(Siberian/1952//Clintafe//Rodney)/4/Roxton/RL1276//Ajax/RL1276///Garry/Klein /5/Shefford/Craig//Garry/Glen

We suggest workers should label it "Marion QC" (abridged MRQ). It is rust susceptible and BYDV susceptible, but its remarkable earliness often allows it to escape disease in Quebec. It is quite tall when grown south of Ouebec, but the straw is reasonably lodging resistant considering the height of the cultivar. It produces a good biomass and a very good yield throughout Eastern Canada; the grain is white, long, plump, and quite heavy (36 grams/100 kernels, when the average in Quebec is 32 grams/1000 kernels). Hectoliter weight is average. The percent hull is 1% less than the average Ouebec cultivars, at 24.6%. With a yield equal to the average of the Quebec trials, Marion ripens 3 days earlier than average. Awns are rare and small.

We hope this line may become a contribution to the development of a better "human food" class of oats. The line is in the Germplasm Bank of Agriculture Canada in Ottawa; we also sent the Canadian Marion to Dr. Wesenberg, the USDA curator, under the name "Marion QC" to indicate that this is the Quebec bred Marion, and not the ancient Iowa line.

The Iowa line Marion is described in "Oat history, identification and classification" (F.A. Coffman 1977, Tech. Bull. 1516 USDA) as a line released in 1940 from a cross Markton x Rainbow made in 1928. Its C.I. number is CI 3247. The plant is described in the same book; the seed has white lemma, and the palea is white and gray flecked. Awns occur occasionally. The kernel is slender to medium plump.

It is hoped that the information supplied here will help avoid future confusion. Thanks to Dr. D. Stuthman for supplying us the history of the older cultivar.

NEW YUGOSLAV SPRING OAT CULTIVARS

Dragoljub Maksimovic, Miodrag Krstic, and Branka Ponos

The Institute for Small Grains in Kragujevac, Yugoslavia is engaged in producing new spring oat varieties. Hybridization and the pedigree selection method are applied in oat improvement, and a great number of combinations and lines have been created.

Two new spring oat varieties 'Rajac' and 'Mediteran' were approved by Yugoslav Variety Approvement Commission in 1987 and 1988, respectively.

Rajac originates from 'Mustang' x 'Astor' and Mediteran from 'Astor' x 'Gambo' crosses. Dr. Dragoljub Maksimovic created them both. Some characteristics of these cultivars are presented in this paper.

Table 1. Some characteristics of new spring oat varieties investigated on six locations in Yugoslavia.

	RAJAC		MEDITERAN	
Characteristic	Year of investigation	Mean	Year of investigation	Mean
Mean grain yield (kg/ha)	1983-1985	3.697	1984-1986	4.105
Highest grain yield (kg/ha)	1985	6.424	1985	6.050
Mean test weight (kg/ha)	1983-1985	43.34	1984-1986	42.90
Mean 1000 kernel weight (kg/ha)	1983-1985	32.18	1984-1986	30.76
Kernel dry matter (%)	1985	93.61	1986	90.32
Kernel organic matter (%)	1985	90.49	1986	87.38
Nonnitrogen extractive substances in kernel (%)	1985	63.59	1986	59.76
Kernel proteins (%)	1985	14.44	1984	11.05
Highest kernel protein content (%)	1983	15.96	1983	15.35
Kernel crude cellulose (%)	1985	10.09	1986	14.76
Kernel crude lipids (%)	1985	2.37	1986	3.40
Kernel mineral matter (%)	1985	3.12	1986	2.94
Mean plant height (cm)	1983-1985	94	1984-1986	106.70

Both Rajac and Mediteran are high yielding with excellent kernel quality. They are in the growing area determination process in agricultural production in Yugoslavia.

ZLATAK

F. Machan, J. Cervenka, F. Benes

'Zlatak' was bred in the Krukanice Breeding Station from a 'Tarpan' x 'Flamingsnova' cross. The KR-175 stem from the combination D-71 x 'Rigal' ('Diadem') was used as a parent for a further cross. In the State Cultivar Trials it was designated KR-TFP.

Zlatak is an early cultivar similar in maturity to 'Veles' with yellow grain.

Zlatak has a moderate number of straight tillers. Leaf color is green and leaves are without hairs with a low twisting intensity (below 90^0), the medium leaf ligule is lightly colored or colorless with a serrated edge. Node shape is very variable. The panicle is spreading, pyramidal, straight, with a triangulate section. Height is medium (1.10-1.30 m) and lodging resistance is good.

This cultivar is more resistant to the second generation of <u>Oscinella</u> frit in comparison to the other released cultivars. Yellow grain has a probstein shape and low husk proportion (24-28%). Husks are greyish green, thousand grain weight is medium to high, 32.6 g on the average, and hectolitre weight is suitable for feeding purposes. Zlatak produces a medium proportion of first-grade grain whose weight of 1000 hulled grains is the highest one of the whole collection. Crude grain protein content is medium.

The cultivar is productive. It produces high yields in all spring oat growing regions, mainly in more humid parts of relatively warm regions. Grain yield reaches the level of Flamingsnova. It responds with yield increase to growing after good forecrops.

Zlatak has no special crop management requirements. Recommended sowing rates are: 4 mil. germinable seeds per ha in the sugarbeet growing region, 5 mil. seeds/ha in the other regions. It is possible to utilize this cultivar at lower sowing rates as a cover crop in leguminous underseeding. The recommended N application rate is 70-100 kg N/ha, according to the yield potential of the location.

Productivity and economic characteristics of oat-varieties CSSR state trials 1986-198

Varieties		1986 $t.ha^{-1}$	1988 %	Vegetation Period days	Height of plant cm	Erysiphe graminis D.C. 9-1	Puccinia graminis Pers. 9-1	Puccinia coronifera Kleb. 9-1	Crude protein %
Pan - S	(CS)	6.16	99	126	113	9	7	7	11.03
Flamingsnova	(D)	6.46	103	122	107	8	7	7-8	10.93
Veles	(CS)	6.00	96	124	109	9	7	7-8	11.40
David	(CS)	6.13	98	125	116	7	6-7	7	11.59
Zlatak	(CS)	6.48	104	124	110	8	7	7	11.18

S = Standard
9 = No disease

GERMPLASM--21 HIGH YIELDING OAT LINES FROM A RECURRENT SELECTION PROGRAM

D.D. Stuthman

Twenty-one lines of oat (Avena sativa L.) have been developed in a recurrent selection program for grain yield conducted at the Minnesota Agricultural Experiment Station. These lines (parents for cycle four, C_4) were selected from 630 F_6 progeny produced from 63 C_3 crosses. The recurrent selection program was begun in 1968 by crossing 12 C_0 parents which were described by Stuthman and Stucker (1). In C_1, C_2, and C_3, 21 lines were crossed in a circulant partial diallel to produce 63 crosses. In all cycles, selection for grain yield was applied first among crosses (best 1/3) and then among the 10 lines from each of the selected crosses. Single seed descent was used to advance generations in each cycle and selection was based on yield of F_6 lines. Testing was done using five replicates of hill plots in a single environment.

As a group, the 21 C_4 parents yielded approximately 22% more than the original group of C_0 parents in preliminary yield evaluations using both hill and row plots over several locations and years. Rankings for grain yield of each line in 1987 are given in Table 1.

Earlier, Payne et al. (2) and Bregitzer et al. (3) compared the C_3 parents to the original C_0 parents for grain yield and various physiological and morphological traits. Payne et al. measured an 11.5% increase in grain yield and also observed increases in grain growth rate, partitioning coefficient, heading date, plant height and above ground biomass dry matter production. Bregitzer et al. measured a 13.5% increase in grain yield as well as increases in leaf size, floret length, and plant height.

Limited quantities of seed of each of these lines are available from the Oat Breeding and Genetics Project, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108. For identification purposes, the lines are designated Mn C_4-1 through -21.

References

1. D.D. Stuthman and R.E. Stucker. 1975. Combining ability analysis of near-homozygous lines derived from a 12-parent diallel cross in oats. Crop Sci. 15:800-803.

2. T.S. Payne, D.D. Stuthman, R.L. McGraw, and P.P. Bregitzer. 1986. Physiological changes associated with three cycles of recurrent selection for grain yield improvement in oats. Crop Sci. 26:734-736.

3. P.P. Bregitzer, D.D. Stuthman, R.L. McGraw, and T.S. Payne. 1987. Morphological changes associated with three cycles of recurrent selection for grain yield improvement in oats. Crop Sci. 27:165-168.

Table 1. Yield rankings of C_4 parents and group means in 1987.

Line designation	Rank in rows*	Rank in hills**
C_4-1	16	12
-2	5	4
-3	2	2
-4	10	1
-5	11	20
-6	13	18
-7	6	16
-8	17	5
-9	7	10
-10	15	12
-11	4	16
-12	9	7
-13	23	22
-14	8	3
-15	22	14
-16	19	11
-17	13	19
-18	3	21
-19	18	8
-20	12	9
-21	20	15
Starter	21	23
Ogle	1	6
	g/plot	
C_0 X	400.5	17.1
C_4 X	432.9	25.1

*Rosemount, Waseca, and Crookston, Minn. and Brookings, S. Dak.
**St. Paul, Minn.

VI. MAILING LIST

M. Aartsma
Small Grain Centre
Private Bag 2C29
Bethlehem 9700
SOUTH AFRICA

Bari Abdallah
Station Centrale des Plantes Fourrageres
INRA BP 415 Guich
Rabat
MOROCCO

Bryce C. Abel
109 Plant Introduction
Iowa State University
Ames, Iowa 50011

Dr. Aristeo Acosta-Carreon
Universidad Autonoma Agraria
"Antonio Narro"
Buenavista Saltillo
Coahuila, MEXICO

Mohammad Al Ajlouni
Department of Agronomy
Iowa State University
Ames, Iowa 50011

Rulon S. Albrechtsen
Plant Science Dept.
Utah State University
Logan UT 84322

Dr. M. W. Alison
Macon Ridge Branch Station
Route 5, Box 244
Winnsboro, LA 71295

Dr. Illimar Altosaar
Professor, Biochemistry Dept.
University of Ottawa
40 Somerset St
Ottawa, Ontario, Canada K1N 6N5

M. J. Ambrose
John Innes Institute
Colney Lane
Norwich Norfolk
ENGLAND

Dr. W. K. Anderson
Dept. Agriculture
Baron-Hay Ct
South Perth, Western Australia 6151

H. M. Anderson
Long Ashton Research Station
Univ. of Bristol
Long Ashton
Bristol, B518 9AF UNITED KINGDOM

Keith Armstrong
Crop Research Division
DSIR, Private Bag
Gore
NEW ZEALAND

Deane C. Arny
Dept. of Plant Pathology
University of Wisconsin
1630 Linden Dr.
Madison, WI 53706

Sr Jose Ascoli
Quaker de Guatemala
6 Av 060 Zona 4
Torre Professional II Oficina 411
Guatemala City, GUATEMALA

Dr. R. E. Atkins
Agronomy Department
Iowa State University
Ames, IA 50011-1010

Mr. I. M. Atkins
521A West 15th St
Hereford, TX 79045

Dr. Robert Bacon
Agronomy Department
115 Plant Science Bldg.
University of Arkansas
Fayetteville, AR 72701

Joe Baecker
Codema, Inc.
7924 73rd Ave. N.
Brooklyn Park, MN 55428

Francisco Bagulho
Natl Plant Breeding Station
P - 7351
Elvas Codex
PORTUGAL

Hakima Bahri
Dept. of Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55108

R. D. Barnett
University of Florida
Route 3 Box 4370
Quincy, FL 32351

Andrew R. Barr
South Australian Dept. of Agric.
G P O Box 1671
Adelaide
SOUTH AUSTRALIA 5001

Manuel T. Barradas
Nat'l Plant Breeding Station 00-068-6284
7350 Elvas
PORTUGAL

D. B. Bechtel
U.S. Grain Marketing Res. Cen.
1515 College Ave.
Manhattan, KS 66502

Abdelkader Benbelkacem
78 Imp. Benbelkocem
Ain M'Lila - W - OEB (04300)
ALGERIA

Edmundo D. Beratto
Instituto Investigaciones Agropecuaria
E. E. Carillanca
Casilla 58-D
Temuco, CHILE

Gary C. Bergstrom
Dept. of Plant Pathology
Cornell University
334 Plant Science Bldg.
Ithaca, NY 14853

Terry Berke
338 Keim Hall
University of Nebraska
Lincoln, NE 68583

Ron Bhatty
Dept. Crop Science
Univ. of Saskatchewan
Saskatoon, Sask.
Canada S7N OWO

Campo Agricola Exp. Stn. Biblioteca
Sierra de Chihuahua
Apdo Postal 554
Cd. Cuauhtemoc, Chih. 31500
Mexico

Cifap-Aguascalientes Biblioteca
Apdo. Poastal No. 20
Pabellon de Arteaga, Ags. 20660
Mexico

Ulrike Bickelmann
Bleichenhofstr. 5
D-7500 Karlsruhe 41
WEST GERMANY

MisspS. A. Black
Border Oats Ltd.
Edington Mill
Chirnside
Berwickshire UNITED KINGDOM

G. R. Boughton
Experimental Farm
P.O. Box 760
Indian Head, Saskatchewan
Canada SOG 2KO

Phil Bregitzer
Dept of Agron/Pl Genetics
University of Minnesota
1509 Gortner Ave.
St. Paul, MN 55108

L. W. Briggle
USDA-ARS PGGI-GIEL
Rm 115, B-001 BARC-West
Beltsville, MD 20705

Marshall A. Brinkman
Agronomy Dept.
University of Wisconsin
Madison, WI 53706

Kalyn Brix
Plant Science Department
South Dakota State University
Brookings, SD 57007

Dr. Uzi Brodny
Department of Botany
Tel-Aviv University
Ramat-Aviv
Tel-Aviv 69978 ISRAEL

Jan B. Broower
Victorian Crops Res. Inst.
Horsham, Victoria 3400
AUSTRALIA

A. R. Brown
Rm 3111 Plant Sci. Bldg.
University of Georgia
Athens, GA 30602

Dr. C. M. Brown
Dept. of Agronomy
University of Illinois
Urbana, IL 61801

J. F. Brown
Botany Dept.
Univ. of New England
Armidale, N.S.W. 2351
AUSTRALIA

P. D. Brown
Agriculture Canada
Res Station De Recherche
195 Dafoe Rd
Winnipeg, Manitoba R3T 2M9

J. A. Browning
Dept. of Pl. Path. & Microbiology
Texas A & M Univ.
College Station, TX 77843

Dr. Frantisek Bruckner
Res. & Plt. Breeding Inst. of Cereals
767 01 Kromeriz, Havlickova 2787
CZECHOSLOVAKIA

P. L. Bruckner
Dept. of Agronomy
Coastal Plain Experiment Station
Tifton, GA 31793-0748

John Bullock
General Mills, Inc.
Box 15003, Commerce Station
Minneapolis, MN 55415

Ron Bunch
Dept. of Agronomy
1575 Linden Drive
Madison, WI 53706

Trond Buraas
Bjorke Forsokgard
2344 Ilseng
NORWAY

David Burnett
Suite 19-9
The Quaker Oats Co.
P. O. Box 9001
Chicago, IL 60604-9001

Dr. Peter A. Burnett
CIMMYT, Lisboa 27
Apdo Postal 6-641
06600 Mexico 6 DF
MEXICO

Vernon D. Burrows
Res. Branch Central Region
Ottawa Res. Station Bldg. 75
Ottawa, Ontario
Canada K1A 0C6

T. R. Butler-Stoney
Welsh Plant Breeding Station
Aberystwyth, Dyfed
UNITED KINGDOM

Hector L. Carbajo
Istilart 189
7500 Tres Arroyos
Buenos Aires
ARGENTINA

Biblioteca Estacion Exp Carillanca
Casilla 58 D
Temuco, CHILE

Keith R. Carlson
American Oat Association
Box 456
Stratford, IA 50249

Gilberto Carvalho
Rua Voluntarios da Patria. 2055
90.230 - PORTO ALEGRE-RS
BRASIL

David H. Casper
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Lic. MA. Del Socorro Iturbe Castillo
Campo Agricola Experimental Valle
De Mexico
APDO. Postal #10
Chapingo, Mexico C.P. 56230

Cebeco-Handelsraad
Plant Breeding Station
P O Box 139
8200 AC Lelystad
NETHERLANDS

Ing. Jaroslav Cervenka
RPBIC-Plant Breeding Station Krukanice
330 36 Pernarec, okres Plzen-sever
CZECHOSLOVAKIA

Al Faiz Chaouki
Station Centrale des plantes fourrageres
INRA BP.415 Guich RABAT
MOROCCO

B. D. Chaudhary
121 Mohalla Chaudharian
Hisar-125 001
INDIA

James Chong
Research Station
195 Dafoe Road
Winnipeg, Manitoba
Canada R3T 2M9

R. N. Choubey
Indian Grassl.& Fod. Res. Inst.
Pahuj Dam
Jhansi-Gwalior Road
284003 U P, INDIA

O. K. Chung
1515 College Ave.
USDA/ARA Grain Mkt Res. Ctr.
Manhattan, KS 66052

Direccion Del CIAMEC-INIA
Apdo. Postal #10
Chapingo, MEXICO

G. Clamot
Stat. D'Amelioration des Plante
Rue du Bordia, 4
B-5800 Gembloux
BELGIUM

R. V. Clark
Research Station Res. Br.
Agriculture Canada Bldg. 75
Ottawa, Ontario
Canada K1A 0C6

B. C. Clifford
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
SY23-3EB
Wales, UNITED KINGDOM

R. B. Clothier
University College of Wales
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
Wales, UNITED KINGDOM

Andre Comeau
Agriculture Canada
2560 Boul Hochelaga
Sainte-Foy, Quebec
Canada G1V 2J3

Tom Conlon
Dickinson Experiment Station
Box 1117
Dickinson, ND 58601

Jose Coutinho
National Plant Breeding Station
7351 Elvas Codex
PORTUGAL

Jim B. Cretney
Robin Hood Multifoods Inc.
1040 Grain Exchange Bldg.
Winnipeg, Manitoba R3B 0W2

Dan Currier
Agronomy Department
Iowa State University
Ames, Iowa 50011

Lynn Dahleen
Dept. of Agron. & Pl. Genetics
University of Minnesota
St. Paul, MN 55108

Bhagwan Das
Dept. of Plant Breeding
Haryana Agri University
Hissar - 125 004
INDIA

Lealand Dean
P O Drawer B
Denton, TX 76201

Dr. J. Dehne
Institut fur zuchtungsforschung
Ethel & Julius Rosenberg Strasse 22/23
43 Quedlinburg
German Democratic Republic

M. C. Mauro R. Zamora Diaz
CEVAMEX - Apdo. Postal #10
Chapingo, Mex. 56230
MEXICO

Amos Dinoor
Dept. of Plant Path & Microbio.
Faculty of Agriculture
Rehovot, ISRAEL

Director
USDA-ARS Grain Mkt Res. Ctr.
1515 College Ave.
Manhattan, KS 66052

Director
Nat'l Seed Storage Lab
Colorado State University
Ft. Collins, CO 80523

Dr. Stephen M. Dofing
Agricultural Experiment Station
533 E. Fireweed
Palmer, AK 99645

Merrill Donoho
General Mills
Box 15003 Commerce
Minneapolis, MN 55415

Regina Dorigoni
Quaker, Apdo Postal 2795
Guatemala
CENTRAL AMERICA

D. Droushiotis
Agricultural Research Institute
Ministry of Agriculture &
Natural Resources
Nicosia, CYPRUS

J. P. Dubuc
Agriculture Canada
2560 Boul Hochelaya
Sainte-Foy, Quebec
Canada

Ronald D. Duerst
Agronomy Dept.
University of Wisconsin
Madison, WI 53706

Philip Dyck
Camp Agricu Exptal Sierra de Chih
Apdo Postal 554
CD Cuauhtemoc Chih 31500
Mexico

Editor
Diversity Magazine
727 8th St. S.E.
Washington, D.C. 20003

Dr. A. H. Ellingboe
Dept. of Plant Pathology
University of Wisconsin
Madison, WI 53706

Dr. A. H. Epstein
Dept. of Plant Pathology
Iowa State University
Ames, Iowa 50011

Janet Erb
1501 Agronomy
Iowa State University
Ames, Iowa 50011

Eric Eriksmoen
Hettinger Res. & Ext. Center
Box 1377
Hettinger, ND 58639

Lars Eskilsson
Weibullsholm PBI Box 520
S-261 24 Landskrona
SWEDEN

Kenneth H. Evans
Plant Variety Protection Office AMS
National Agricultural Library Bldg.
Rm 500
Beltsville, MD 20705

Dr. Zahir Eyal
Dept. of Botany
Tel-Aviv University
Ramat-Aviv, Tel-Aviv 69978
ISRAEL

Duane E. Falk
Dept. of Crop Science
Ontario Agricultural College
University of Guelph
Guelph, Ontario, Canada N1G 2W1

Mark Farnham
Dept. of Agron. & Pl. Genetics
University of Minnesota
St. Paul, MN 55108

Wade F. Faw
255 Knapp
Louisiana State University
Baton Rouge, LA 70803

H. A. Fisher
1621 8 St. N.
Fargo, ND 58102

R. W. Fitzsimmons
Dept. of Agric.
7 Womora Ave.
Wahroonhga
N.S.W., AUSTRALIA 2076

John Flahavan
E. Flahavan & Sons Limited
Kilmacthomas
County Waterford
IRELAND

Darlene Fleig
Agronomy Department
Iowa State University
Ames, Iowa 50011

Eng Agr Elmar Luiz Floss
Rua Dom Vidal, 38
Cx. Postal 271
99100 - PASSO FUNDO - RS
BRAZIL

Dr. Robert A. Forsberg
Dept. of Agronomy
University of Wisconsin
Madison, WI 53706

J. E. Foster
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

Dr. Brad Fraleigh
Plant Gene Resource of Canada
Plant Research Centre Bldg. #99
Research Branch, Agriculture Canada
Ontario, Canada K1A 0C6

Dr. Russell Freed
Crop & Soil Science Dept.
Michigan State University
East Lansing, MI 48824

Dr. Judith Fregeau
Plant Physiologist
Plant Research Center
CE.E.F. Bldg 75
Ottawa, Ontario, Canada K1A 0C6

Dr. K. J. Frey
Agronomy Dept.
Iowa State University
Ames, Iowa 50011-1010

M. Frost
Division of Animal Production
CSIRO, P O Box 239
Blacktown N.S.W.
AUSTRALIA 2148

Lynn W. Gallagher
Rabat-ID
% USAID
Washington, DC 20523

Salvador Galvan-Lamas
INIA-CIAN-CAESICH
Calle 4a. No. 262, APDO. Postal No 554
CD. Cuauhtemoc, Chic.
MEXICO

Robert G. Ganly
12 Cannes Court
Highton, 3216
Victoria, AUSTRALIA

James H. Gardenhire
607 Mimosa
Denton, TX 76201

Clamot Georges
Station d'Amelioration des Plantes
Rue du Bordia, 4
B-5800 GEMBLOUX BELGIUM

K. D. Gilchrist
Agronomy Dept.
University of Wisconsin
Madison, WI 53706

E. C. Gilmore
Soil & Cop Sciences
Texas A & M University
College Station, TX 77843

C. I. Goellner
Caixa Postal 569
Embrapa
Passo Fundo R S
BRAZIL

C. A. Jimenez Gonzalez
Invest Prog. Avena
Apdo Postal 10
Chapingo, MEXICO

Robert W. Gooding
Dept. of Agronomy
Ohio Ag Res & Dev Center
Ohio State University
Wooster, Ohio 44691

David G. Goslin
The Quaker Oats Co. of Canada Ltd
Quaker Park
Peterborough, Ontario,
Canada K9J 7B2

Dr. Craig Grau
Dept. of Plant Pathology
University of Wisconsin
Madison, WI 53706

Mrs. J. Green
Institute of Plant Science Research
Trumpington, Cambridge CB2 2JB
ENGLAND

Carl A. Griffey
Department of Agronomy
Virginia Polytechnic Institute and
State University
Blacksburg, VA 24061

T. E. R. Griffiths
University College of Wales
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
Wales, UNITED KINGDOM

L. Guarino
IBPGR c/o ARI
P. O. Box 2016
Nicosia CYPRUS

Magne Gullord
Apelsvoll Research Station
N-2858 KAPP
NORWAY

Dr. S. K. Gupta
Principal Investigator (Plant Breeding)
AICRP on Forage Crops, I.G.F.R.I.
Jhansi 284003 (U.P.)
INDIA

Bibliotheek de Haaff
Stichtng Voor Plantenveredeling
Postbus 117 - 6700 AC
Wageningen, NETHERLANDS

Steve Haber
Agriculture Canada
Research Station de Recherche
195 Dafoe Rd
Winnipeg, Manitoba R3T 2M9

Per Hagberg
Svalof Ab
S-26800 Svalov
SWEDEN

Lon Hall
Plant Science Dept.
South Dakota State University
Brookings, SD 57007

Richard P. Halstead
Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55108

James J. Hanzel
Agronomy Dept.
North Dakota State University
Fargo, ND 58105

D. E. Harder
Research Station
195 Dafoe Rd
Winnipeg, Manitoba
Canada R3T 2M9

Leland L. Hardman
Agronomy & Pl Genetics Dept.
411 Borlaug Hall
University of Minnesota
St. Paul, MN 55108

H. F. Harrison
Coker's Pedigreed Seed Co.
P O Box 340
Hartsville, S.C. 29550

Stephen A. Harrison
Dept. of Agronomy
221 M.B. Sturgis Hall
Louisiana State University
Baton Rouge, LA 70803-2110

Robert Harrold
Animal Science Dept.
North Dakota State University
Fargo, ND 58105

Prof. J. D. Hayes
Univ. College of Wales
Dept. of Agriculture
Penglais Aberystwyth Dyfed SY23, 3DD
UNITED KINGDOM

M. D. Hayward
Crop Improvement Division
Walsh Plant Breeding
Plas Gogerddan Near Aberystwyth
Wales, UNITED KINGDOM

Dr. James Helm
Agronomy Dept.
North Dakota State University
Fargo, ND 58105-5051

Dr. Cynthia A. Henson
Dept. of Agronomy
University of Wisconsin
Madison, WI 53706

Anna Hewing
Agronomy Dept.
University of Illinois
Urbana, IL 61801

Dennis A. Himschoot
United Grain Growers, Seed Division
7410 - 120 Avenue
Edmonton, Alberta, Canada
T5B 4K5

David Hoffman
University of Idaho R & E Center
P. O. Box AA
Aberdeen, Idaho 83210

Linwood Hoffman
USDA Economic Research Service
Rm 1034-A 1301 NY Ave. NW
Washington, DC 20005-4788

John Holden
The Steading
Yarrow
Selkirk
SCOTLAND

Geraldine R. Horton
Quaker Oats Research Library
617 W. Main Street
Barrington, IL 60010

Mark E. Hughes
Cereal Rust Laboratory
University of Minnesota
St. Paul, MN 55108

H. David Hurt
The Quaker Oats Company
617 West Main St.
Barrington, IL 60010

Institute of Sci. & Tech. Inf. for Agric
Slezska 7
120 56 Praha 2
CZECHOSLOVAKIA

International Rice Research Inst.
Library & Documentation Ctr.
P O Box 933
Manilla, PHILLIPINES

Norio Iriki
Agronomy Dept.
Hokkaido Nat. Agr. Exp. Sta.
Hitsujigaoka, Toyohira
Sapporo 004, JAPAN

Jim Jakicic
Hettinger Research Extension Center
Box 1377
Hettinger, ND 58639

R. E. Jarrett
Crop Science Dept.
North Carolina State Univ.
Raleigh, NC 27695-7620

Dr. D. S. Jatasra
Dept. of Plant Breeding
Haryana Agricultural University
Hisar - 125 004
INDIA

Russell Jeffrey
Box 6030, Stn "C"
7410 - 120 Avenue
Edmonton, Alberta, Canada T5B 4K5

Neal F. Jensen
5416 Thomas Court N.E.
Albuquerque, NM 87111

Ing Gerardo Valdes Jimenez
U A A A N Programa De Cereales
Buenavista
Saltillo COAH
MEXICO

Christine Joannides
Victorian Crops Research Institute
Natimuk Road Private Bag 260
Horsham, Victoria 3400
AUSTRALIA

David R. Johnson
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

I. T. Jones
Pathogen & Pest Resistance Group
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
SY23-3EB, Wales, UNITED KINGDOM

J. E. Jones
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
SY23-3EB Wales, UNITED KINGDOM

N. Jordan
Twyford Seeds Ltd.
Kings Sutton, Banbury
Oxon OX17 3QW
ENGLAND

Omar Kafawin
Plant Science Dept.
South Dakota State University
Brookings, SD 57007

Russ Karow
Crop Science Dept.
Oregon State University
Corvallis, OR 97331

D. S. Katiyar
Scientist-S2
Indian Grass. & Fod. Res. Inst.
Jhansi, INDIA 284003

Prof. James A. Kavanagh
Dept. of Plant Pathology, Agric. Bldg.
University College, Dublin
Belfield, Dublin 4, IRELAND

P. J. Keane
Latrobe University
Botany Dept.
Bundoora Victoria
AUSTRALIA 3083

Cal Kelly
Oat Marketing & Research Coordinator
Head Office, 499 Hoffer Drive
Regina, Saskatchewan S4N 6E2
Canada

R. L. Kirkby
The Oats Marketing Board
Box R196, P O Royal Exchange
Sydney N.S.W.
AUSTRALIA

A. E. Kirton
Canadian Wheat Board
423 Main St. Box 816
Winnipeg, Canada R3C 2P5

Dr. C. Kishor
Department of Plant Breeding
Haryana Agricultural University
Hisar - 125 004
INDIA

Dr. H. R. Klinck
Fac. of Agric., Plant Science Dept.
MacDonald Campus of McGill Univ.
21111 Lakeshore Road
Ste Anne De Bellevue, P Quebec H9X 1C0

Frederic L. Kolb
Agronomy Department
University of Illinois
Urbana, IL 61801

Peter Kolln
Muhlenwerke
D2200 Elmshorn
WEST GERMANY

C. F. Konzak
Agronomy Department
Washington State University
Pullman, WA 99164

Kiro Dimov Kostov
Plant Introduction Inst.
Sadavo
Plovdiv, BULGARIA

Gene Krenzer
Dept. of Agronomy
Oklahoma State University
375 Agricultural Hall
Stillwater, OK 74078

Bo Kristiansson
Svalof AB S-268 00
Svalov, SWEDEN

Professor T. I. Krivchenko
All-Union Institute of Plant Production
Leningrad - Pushkin
ul. Gercena 44
USSR

Takeshi Kumagai
Hokkaido Nat Agr Exp Sta
Higashi 1 jo 10 chome 2-15
Tsukisamu, Toyohira
Sapparo 062, JAPAN

J. Kumar
Hill Campus
G.B.Paut
Ranichuri 249199
Tehri (U.P.) INDIA

Dr. Manfred Kummer
Institut fur Zuchtungsforschung
Ethel und Julius Rosenberg Strasse 22/23
43 Quedlinburg
GERMAN DEMOCRATIC REPUBLIC

Greg Kushnak
Agr Research Center
P O Box 1474
Conrad, MT 59425

Hans Kuuts
The Jogeva Plant Breeding Station
202 350 Jogeva
Estonian SSR
USSR

Gideon Ladizinsky
Faculty of Agriculture
The Hebrew University
P. O. Box 12
Rehovot, ISRAEL

Dr. H. N. Lafever
Agronomy Dept.
Ohio Agr. Res. & Dev. Ctr.
Wooster, OH 44691

Salvador Galran Lamas
Calle 4a. N. 262
Apdo. Postal N 554
Cd. Cuauhtemoc, Chih.
MEXICO

T. Lambert
Twyford Seeds Ltd.
Scotts Farms, Kings Sutton
Banbury
Oxon, ENGLAND

Arthur Lamey
Plant Pathology Dept.
North Dakota State University
Fargo, ND 58105-5012

Risto Lampien
Lansi-Hchkiala
SF-14700 Hauho
FINLAND

Michael Lane
Pillsbury Company
480 Grain Exchange
Minneapolis, Mn 55415

William Lapp
Con-Agra Inc.
Con-Agra Center
#1 Central Park Plaza
Omaha, NE 68102

Warren Larson
University of Alaska Fairbanks
Cooperative Extension Service
34820 College Dr., Suite 2
Soldotna, AK 99669

D. A. Lawes
Welsh Pl Breed Station
Plas Gogerddan Near Aberystwyth
SY23-3EB Wales
UNITED KINGDOM

J. E. Lea
Morning Foods Limited
Northwestern Mills
Crewe, CW2 6HP
Cheshire, ENGLAND

Philip Lea
Morning Foods Limited
Northwestern Mills
Crewe, CW2 6HP
Cheshire, ENGLAND

Steven Leath
Dept. of Plant Pathology
Box 7616, NCSU
Raleigh, NC 27695-7616

J. M. Leggett
Welsh Plant Breeding Sta.
Plas Gogerddan
Aberystwyth Dyfed
UNITED KINGDOM

Norbert Leist
Lufa-Augustenbberg
Nesslerstrasse 3
D-7500-Karlsruhe 41
WEST GERMANY

Marvin Lenz
Quaker Oats Co.
617 W Main St.
Barrington, IL 60010

Kurt Leonard
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Albert R. Mann Library
Acquisitions Division
Cornell University
Ithaca, New York 14853-4301

Central Scientific Agric. Library
Dept. of Inter. Book Exchange
Orlikov bystreet, 3
Moscow, B-139, USSR

R. M. Lister
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

David Livingston
USDA, ARS
U. S. Regional Pasture Lab
Curtin Rd
University Park, PA 16802

David L. Long
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Ing. Igor Longauer
Plant Breeding Station
Pstrusa-Viglas, okres Zvolen
CZECHOSLOVAKIA

Dr. G. Lookhart
USDA
1515 College Ave.
Manhattan, KS 66502

O. W. Luetkemeier
Agronomy Dept.
Purdue University
Lafayette, IN 47907

Peter Lynch
Agronomy Department
Iowa State University
Ames, Iowa 50011

E. V. Lyzlov
Agricultural Research
Institute Nonchernozeme Zone
143013 Nemchinowka-1
Moscow Region, USSR

Benvindo Martins Macas
National Plant Breeding Station
7351 Elvas Codex
PORTUGAL

M. C. Mackay
Australian Winter Cereals Collection
Private Mail Bag, R M B 944
Tamworth, N.S.W.
AUSTRALIA 2340

James MacKey
Swedish Univ. of Agr. Science
Plant Breeding
S-750 07 Uppsala
SWEDEN

W. F. Mai
Plant Pathology Dept.
Plant Science 310
Cornell University
Ithaca, NY 14853

Dragoljob Maksimovic
Institute for Small Grains
34 000 Kragujevac
YUGOSLAVIA

Michael F. Malecha
Ralston Purina Co
P. O. Box 3588
Davenport, IA 52808

P. L. Manchanda
Cummings Laboratory,Div.of Genetics
IARI
New Delhi 110012 INDIA

Jacob Manisterski
Institute for Cereal Crops Imp.
Tel Aviv University
Ramat Aviv, 6997-8 ISRAEL

Dr. H. G. Marshall
R.D. 2, Box 230
Bellefonte, PA 16823

Dr. J. W. Martens
Agriculture Canada
Research Station
195 Dafoe Road
Winnipeg, Manitoba R3T 2M9

Jim Martin
LaCrosse Milling Co.
Cochrane, WI 54622

Bengt Mattsson
Svalof AB 268 00
Svalof, SWEDEN

Miss J.E. Maughan
Chief Librarian
Western Australian Dept. of Agriculture
Baron-Hay Court
South Perth 6151, Western Australia

Maria Mazaraki
Plant Breed Institute
30-423 Cracow
4 Zawila Str
POLAND

Dr. M. E. McDaniel
Soil & Crop Sciences Dept.
Texas A & M University
College Station, TX 77843

J. M. McEwan
Crop Research Division
D SIR, Private Bag
Palmerstown North
NEW ZEALAND

John McFerson
Asgrow Seed Co.
3501 N. Town Hall Rd. RR2
Janesville, WI 53545

Anne L. McKendry
Department of Agronomy
106 Curtis Hall
University of Missouri
Columbia, MO 65211

Dr. R.I.H. McKenzie
Agriculture Canada
Research Station
195 Dafoe Road
Winnipeg, Manitoba R3T 2M9

R. J. McLean
W. Aust. Dept. of Agriculture
Baron-Hay CRT
South Perth
WESTERN AUSTRALIA 6151

Marcia V. McMullen
Plant Pathology Dept.
North Dakota State University
Fargo, ND 58105

Mike McMullen
Agronomy Dept.
North Dakota State University
Fargo, ND 58105-5051

Renato Borges De Medeiros
Av. Panamericana, 337/302
90.050 - Porto Alegre - RS
Brasil

Leonard Michel
77 Westbury Drive
Bella Vista, AR 72714

A. Micke
FAO-IAEA Div Wien
P O Box 100
A-1400 Vienna
AUSTRIA

B. Middleton
University College of Wales
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
Wales, UNITED KINGDOM

K. Mikkelsen
Vonotkesvei 5
N-1430 As
NORWAY

J. D. Miller
Plant Pathology Dept.
North Dakota State Univ.
Fargo, ND 58105

James Mills
Nor Oats, Inc.
P.O. Box 399
St. Ansgar, Iowa 50472

S. N. Mishra
Dept. of Plant Breeding
G. B. Pant Univ Agr & Tech
Pantnagar 263 145 Dist
Nainital (U.P.) INDIA

Dr. Bimal Misri
Indian Grass & Fod Res Inst.
Manasbal 196 504
J & K State
INDIA

Rene Monzon
Torre Profesional II - Of. 411
Centro Comercial Zona 4
6a Av. 0-63, Zona4
Guatemala City, Guatemala, C.A.

Ing. M. S. Jose Luis Morales
Calle 30a. # 4810-A
Col. Dale
Chihuahua, Chih. Mexico 31050

George H. Morgan
Small Grains Bldg.
Agronomy Dept.
Oklahoma State University
Stillwater, OK 74078

Toshinobu Morikawa
Lab of Genetics & Plant Breeding
College of Agriculture
University of Oscka Prefecture
Sakai, Osaka 591 JAPAN

Hal Moser
Agronomy Department
Iowa State University
Ames, IA 50011

Jimmie Mowder
USDA/ARS/DA/PGGI
BARC-W, Bldg. 001, Rm 130
Beltsville, MD 20705

J. Mulkey
1619 Garner Field Rd
Uvalde, TX 78801

Dr. Kurt Muller
VEG Saatzucht Petkus
Institut fur Getreidezuchtung
1711 Petkus
GERMAN DEMOCRATIC REPUBLIC

Technische Universitat Munchen
Lehrstuhl fur Pflanzenbau und
Pflanzenzuchtung
805 Freising-Weihenstephan
WEST GERMANY

Chris Mundt
Dept. of Botany & Plant Pathology
Oregon State University
Corvallis, OR 97331-2902

Aage Munk
Landbrugents Kornforaedling
Noerremarksveg 67 Sejet
Dk 8700 Horsens
DENMARK

Kouj Murai
Takarazuka Res. Center
4-2-1 Takatsukasa
Takarazuka, Hyogo, 665
JAPAN

Dr. Charles F. Murphy
USDA, ARS, NPS
Bldg. 005, BARC-W
Beltsville, MD 20705

Paul Murphy
Crop Science Dept.
North Carolina State Univ.
Raleigh, NC 27695-7620

Estacao Nacional
De Melhoramento de Plantas
ATTN: J. Contusky
Elvas
PORTGUAL

Annette Nassuth
Botany Department
University of Guelph
Guelph, Ontario
Canada N1G 2W1

Manuel Navarro-Franco
INIFAP-CIAMEC
Apdo Postal No 10
56230 Chapingo, Mex
MEXICO

H. A. Van Niekert
Private Bag X29
Bethlehem 9700
REPUBLIC OF SOUTH AFRICA

J. J. Nielsen
Agriculture Canada
Res Sta, 195 Dafoe Road
Winnipeg, Manitoba
Canada R3T 2M9

W. C. Niemans-Verdriee
Instituut Voor Plantenveredeling
PostBus 386
6700 AJ Wageningen
NETHERLANDS

Ichizo Nishiyama
18-Hazamacho, Shugaku-in
Sakyoku Kyoto 606
JAPAN

J. D. Oates
Pl. Brdg. Inst.
P. O. Box 180
Castle Hill - University of Sydney
N.S.W. 2154 AUSTRALIA

Dr. H. W. Ohm
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

W. H. Oliver
P. O. Box 148
Lindfield 2070
NSW, AUSTRALIA
02/46-4785

Edward S. Oplinger
Agronomy Dept.
363 Moore Hall
University of Wisconsin
Madison, WI 53706

Yukio Ozeki
Hokkaido Nat. Agr. Exp. Sta.
Hitsujigaoka, Toyohira
Sapporo 004, JAPAN

K. W. Pakendorf
Small Grain Centre
Private Bag X29
Bethlehem 9700
Republic of South Africa

Andras Palagyi
Cereal Research Institute
Szeged
P O Box 391
HUNGARY 6701

Y. C. Paliwal
Chem & Biology Res Inst.
Research Branch, Canada Agric.
Ottawa, Ontario
Canada K1A 0C6

R. S. Paroda
Dept. of Plant Breeding
Haryana Agricultural University
Hissar
INDIA 12500-4

Anna L. Parry
Plant Pathology Dept.
Welsh Plant Breeding Station
Plas Goggerddan Near Aberystwyth
S&23-3EB Wales, U.K.

H. Pass
Agronomy Dept.
Oklahoma State University
Stillwater, OK 74074

B. D. Patil
Indian Grassland & Fodder Res.Inst.
Pahuj Dam, Jhansi-Gwalior Rd
Jhansi-284003 (U P)
INDIA

George Patrick
Agronomy Dept.
Iowa State University
Ames, Iowa 50011-1010

F. L. Patterson
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

Thomas S. Payne
CIMMYT
Lisboa 27, Apdo. Postal 6-641
06600 Mexico, D.F.
Mexico

Bill Pederson
Atwood-Larson Co.
876 Grain Exchange
Minneapolis, MN 55415

Robert E. Perdue
ARS, USDA
Room 366, Bldg. 001
BARC-West
Beltsville, MD 20705

Dr. Federico Cuevas Perez
Instituto Superior de Agricultura
Apartado de Correos 166
La Herradura Santiago
Dominican Republic

John Pesek
Agronomy Department
Iowa State University
Ames, Iowa 50011

D. M. Peterson
Agronomy Dept.
University of Wisconsin
Madison, WI 53706

P. L. Pfahler
Agronomy Dept.
304 Newell Hall
University of Florida
Gainesville, FL 32611

R. L. Phillips
Dept. of Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55108

C. A. St. Pierre
Agriculture Canada
2560 Boul Hochelaya
Sainte-Foy
Quebec, Canada

Kevin Pixley
Agronomy Department
Iowa State University
Ames, Iowa 50011

Wieslaw Podyma
National Dept.of Plant Genetic Resources
Plant Breeding and Acclimatization Inst.
05-870 Blonie
POLAND

J. M. Poehlman
Dept. of Agronomy
109 Curtiss Hall
University of Missouri
Columbia, MO 65211

Y. Pomeranz
1515 College Ave.
USDA/ARS Grain Mkt Res Cen.
Manhattan, KS 66502

Peter Portmann
Dept. of Agriculture
Jarrah Road
South Perth
AUSTRALIA WA 61S 1

J. Postoyko
Dept. of Biological Sciences
John Dalton Building
Manchester Polytechnic
Oxford Road, Manchester, U.K.

M. N. Premachandran
Indian Grassland & Fodder Res Inst.
Pahuj Dam
Jhansi-Gwalior Road
UP INDIA 284 003

Dr. C. O. Qualset
Assoc. Dean Plant Science
Univ. of California-Davis
Agricultural Experiment Station
Davis, CA 95616

Dr. Alfredo Carballo Quiroz
Centro de Genetica
Colegio de Postgraduados
Apdo Postal 1
Chapingo, MEXICO CP 56230

Ignació Ramirez
Instituto de Investigaciones
Agropecuarieas
Casilla 5427 / La Platina
Santiago, CHILE

Mark Ramsland
Burdick Grain Co.
730 2nd Ave. S.
Minneapolis, MN 55402

M. V. Rao
Wheat Project Director
IARI
New Delhi, INDIA 11001-2

Ranjini Rasaiah
MAFF, Nobel House
17, Smith Square
London, SWIP 3JR
UNITED KINGDOM

Marty Reagan
International Multifoods Inc.
Multifoods Tower, 33 South 6th Street
Box 2942
Minneapolis, MN 55402

Dale L. Reeves
Plant Science Dept.
South Dakota State University
Brookings, SD 57006

Dr. V. H. Reich
Agronomy Dept.
University of Tennessee
Knoxville, TN 37901

E. Reinbergs
Crop Science Dept.
University of Guelph
Guelph, Ontario
Canada N1G 2W1

Lars Reitan
Statens Forskingsstasjon Kvithamar
7500 Stjordal
NORWAY

Matti Rekunen
Hankkija Plant Breeding Inst.
SF-04300 Hyryla
FINLAND

Dr. Daniel B. Reynolds
LSU N.E. Exp. Station
P. O. Box 438
St. Joseph, LA 71366

James Reysack
Dept. of Agronomy & Plant Genetics
411 Borlaug Hall
1991 Buford Circle
St. Paul, MN 55108

W. G. Richardson
20 Hill Rise
Woodstock, Oxford
OX7 1AB
ENGLAND

Howard W. Rines
Agron & Plant Genetics Dept.
303 Agronomy Bldg.
University of Minnesota
St. Paul, MN 55108

Neil Riveland
Williston Branch Station
Box 1445
Williston, ND 58801

G. Roberts
Temora Agric. Research Sta.
P O Box 304
Temora, N S W 2666
AUSTRALIA

Larry Robertson
Ext. Crop Management Specialist
University of Idaho
1330 Filer Avenue East
Twin Falls, ID 83301

H. W. Roderick
Welsh Plant Breeding Station
Plas Gogerddan
Aberystwyth SY23 3EB
Dyfed, WALES p

A. Bruce Roskens
The Quaker Oats Company
418 2nd St. N.E.
Box 1848
Cedar Rapids, IA 52406

Marketta Saastamoinen
Dept. of Plant Breeding
Agricultural Research Center
31600 Jokionen
FINLAND

David J. Sammons
Dept. of Agronomy
University of Maryland
College Park, MD 20742

John F. Schafer
Cereal Rust Laboratory
University of Minnesota
St. Paul, MN 55108

John W. Schmidt
322 Keim Hall - East Campus
University of Nebraska
Lincoln, NE 68583

Dr. Dale Sechler
135 Mumford Hall
Agronomy Dept.
U. of Missouri-Columbia
Columbia, MO 65211

Head Library Services
Indian Agric. Research Inst.
(Pusa) Library
New Delhi, 110012, INDIA

G. E. Shaner
Botany & Pl. Pathology Dept.
Purdue University
W. Lafayette, IN 47907

Steve Simmons
Dept. of Agron. & Pl. Genetics
University of Minnesota
St. Paul, MN 55108

Alan P. Roelfs
Cereal Rust Laboratory
University of Minnesota
St. Paul, MN 55108

Dr. Brian Rossnagel
Crop Development Centre
Univ. of Saskatchewan
Saskatoon, Sask. Canada S7N 0W0

Gobind T. Sadaranganey
Multifoods Inc., Technical Centre
191 Attwell Drive
Rexdale, Ontario M9W 5Z2

Shinnosuke Sato
Oat Breeding Lab
Kyushu National Agric.Experiment Station
Nishigoshi, Kumamoto 861-11, JAPAN

Dr. C. W. Schaller
Agron/Range Sci. Dept.
University of California
Davis, CA 95616

Donald J. Schrickel
2502 E. Shaw Butte Dr.
Phoenix, AZ 85028

Serials Section
University Library
University of California
Davis, CA 95616-5292

Dr. M. H. Shah
Imran Villa
Bagat Barzalla
Srinager Kashmir 190005
INDIA

Leslie Shugar
W. G. Thompson & Sons Ltd.
R#1 Ailsa Craig& Sons Ltd.
c/o Nairn Research Lab
Ontario Canada NOM 1A0

Marr D. Simons
18013 Willowbrook Drive
Sun City, AZ 85373

W. J. Rogers
Cytology Dept. W.P.B.S.
Plas Gogerddan Near Aberystwyth
SY23-3EB Wales
UNITED KINGDOM

Dr. P. G. Rothman
Cereal Rust Lab.
Univ. of Minnesota
St. Paul, MN 55108

Dr. Warren Sahs
Rm 107 Agric. Hall
East Campus, UNL
Lincoln, NE 68583

Laurent Saur
I.N.R.A.
Station d Amelioration des plantes
B.P. 29
35650 LE RHEU, FRANCE

Mr. Roberto Schefer
Quaker - Virrey Del Pino 2458
1426 Buenos Aires
ARGENTINA

Grace Schuler
310 Bessey Hall
Iowa State University
Ames, Iowa 50011-1020

Adrian Segal
Tel Aviv University
Faculty of Life Sciences
Institute for Cereal Crops Impr.
Ramat Aviv, ISRAEL

Dr. H. L. Shands
Agronomy Dept.
Univ. of Wisconsin
Madison, WI 53706

Jose A. Sierra
Malteries, De Columbia
S. A. Calle 31 No. 13B-79
Bogata, Columbia
SOUTH AMERICA

E. Simpson
Twyford Seeds Ltd
Scott's Farm
Kings Sutton, NB.Banbury
Oxon, OX17 3WQ UNITED KINGDOM

Magnus Roland
Weibullsholm Pl Breed Inst.
Bjertorp
535 00 Kvanum,
SWEDEN

Paul Rowoth
107 Curtis Hall
University of Missouri
Columbia, MO 65211

Dr. Jose Juan Salmeron-Zamora
APDO. Postal No. 554
CD. Cuauhtemoc, Chic. 31500
MEXICO

Jack Scanlan
National Oats Company
1515 H. Avenue N.E.
Cedar Rapids, IA 52402

Harm Schipper
Agronomy Department
Iowa State University
Ames, Iowa 50011

Josef Sebesta
Ripp-Plant Protection Div.
161 06 Prague 6 Ruzyne 507
CZECHOSLOVAKIA

Jayne T. Semple
Station De Recherche
5, rue de l'Egalite
CHARTAINVILLERS
28130 MAINTENON FRANCE

Henry L. Shands
USDA, ARS, NPS
Rm 140, Bldg. 005
BARC-West
Beltsville, MD 20705

Campo Experimental Sierra De Chihuahua
Apdo. Postal No. 554
CD. Cuauhtemoc, Chihuahua
C.P. 31500 MEXICO

H. J. Sims
21 Morwell Avenue
Watsonia
Victoria 3087
AUSTRALIA

Ronald Skrdla
Agronomy Department
Iowa State University
Ames, Iowa 50011

A. E. Slinkard
Crop Science Dept.
University of Saskatchewan
Saskatoon, Sask.
Canada S7N OWO

E. L. Smith
Agronomy Dept.
Oklahoma State University
Stillwater, OK 74074

Gordon Smith
Quaker Oats Limited
P O Box 24, Bridge Road
Southall, Middlesex UB24AG
ENGLAND

Harry J. Smith
Quaker Oats Co. of Canada
Quaker Park
Peterborough, Ontario
Canada K3J 7B2

W. Smyth
Speedicook Ltd., Scarva Road
Tandragee
Co. Armagh BT62 2BY
IRELAND

Dr. Siegfried V. Soledad
c/o Vals Stylistics
Tagum, North Davao
Phillipines 9401

Manuel Somoza
Juan Mata Ortiz No 303
C P 31700
Nuevo Casas Grandes Chih
MEXICO

Dr. M. E. Sorrells
Plant Breeding Dept.
252 Emerson
Cornell University
Ithaca, NY 14853

Dr. Frank W. Sosulski
Department of Crop Science
University of Saskatchewan
Saskatoon, Saskatchewan, Canada
S7N OWO

James Stage
Dept. of Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55108

Ing. J. Stankova
Central Agricultural & Forestry Library
120 56 Praha 2- Vinohrady, Slezska 7
CZECHOSLOVAKIA

Dr. T. M. Starling
Dept. of Agronomy
Virginia Polytechnic Inst.
Blacksburg, VA 24061

D. Stoyanov
Institute of Introduction & Plant
Genetic Resources
4122 Sadovo Near Polvdiv
BULGARIA

Margaret H. Streutker
Small Grain Center
Private Bag X29
Bethlehem 9700
REPUBLIC OF SOUTH AFRICA

Dr. D. D. Stuthman
Dept. of Agron. & Pl. Genetics
University of Minnesota
St. Paul, MN 55108

Mgr. Andrzej Swierczewski
ZHR Wielopole
33-300 Novy Sacz, skv.p. 117
POLAND

Seiji Tabata
Agronomy Dept.
Hokkaido Nat Agr Exp Sta
Hitsujigaoka Toyohira
Sapporo 004 JAPAN

Akitoshi Tajimi
Hokkaido National Agric.Exp. Sta.
Hitsujigaoka Toyohira-Ku
Sapporo 004
JAPAN

Hiroyuki Takada
Agronomy Dept.
Hokkaido Nat. Agr. Exp. Sta.
Hitsujigaoka, Toyohira
Sapporo 004, JAPAN

Dr. G. Allan Taylor
Dept. of Agronomy
Montana State University
Bozeman, MT 59715

Eldon E. Taylor
Plant Variety Protection Office
L & S Division, AMS, USDA
Natl. Agric. Library, Rm 500
Beltsville, MD 20705

H. F. Taylor
Long Ashton Research Division
Weed Research Division
Yarnton, Oxford OX5 1PF
UNITED KINGDOM

Michael Taylor
Nickerson Pflansenzucht (N.P.Z.)
West Ende 8
3160 Arpke
Lehrte, WEST GERMANY

Geoff R. Tempest
Goodman Fielder Waitie Ltd.
Cereal Milling & Poultry Division
P. O. Box 951
Auckland.1 NEW ZEALAND

Hugh Thomas
Welsh Plant Breeding Station
Plas Gogerddan
Aberystwyth, DYFED
Wales, UNITED KINGDOM

Ronald C. Thomason
Division of Agriculture
Box 998 W. T. Station
Canyon, TX 79016

Curt Thompson
North Central Res. Ext. Center
Rt 3, Box 174
Minot, ND 58701

Juan Carlos Tomaso
I.N.T.A. Estacion Experimental
Agro Pecuaria
8187 Bordenave
Prov. De Buenos Aires, ARGENTINA

Walter Tonelli
Corso Statuto 26
12084 Mondovi (Cuneo)
ITALY

Mr. Romulo Trombetta
Elaborador Argentina de Cereales S.A.
Cereal Plant
Barracas 388
(1275) Buenos Aires ARGENTINA

J. Truter
Winter Rainfall Region
Private Bag
Elsenburg 7607
REPUBLIC OF SOUTH AFRICA

Koichpiro Tsunewaki
Faculty of Agriculture
Kyoto University
Kitashira Kawa, Sakyo-ku
Kyoto 606 JAPAN

J. C. Turner
Quaker Oats Ltd.
P. O. Box 24
Bridge Rd., Southall
Middlesex, ENGLAND

Mrs. C. Tustain
Twyford Seeds Limited
Scotts Farm, Kings Sutton
Banbury, Oxon, ENGLAND

Dr. Cetin Tuten
Aegean Regional Agric. Inst. (ARARI)
P. O. Box 9
Menemen/IZMIR
TURKEY

Yasufumi Ueyama
Kyushu National Agric.Experiment Station
Grassland Division
Nishigoshi, Kumamoto 861-11
JAPAN

Cornell University
Aquisitions Division
Albert R. Mann Library
Ithaca, NY 14853-4301

Dr. J. Valentine
University College of Wales
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
Wales, UNITED KINGDOM

J. Van Der May
Small Grain Centre
Private Bag X29
Bethlehem 9700
REPUBLIC OF SOUTH AFRICA

W. H. Vander Vliet
Caixa Postal 1169 Carambei
CEP8417 Parana
BRASIL

M. Vanselow
Institut fur Angewandte Genet.
Universitat Hannover
Hannover
WEST GERMANY

Matilde Martinez Vasquez
Comunidad de Madrid
Servicio Investigacion Agraria - Ap.127
Alcala de Henares (MADRID)
SPAIN

L. M. Vergasa
International Rice Res. Inst. Library
P. O. Box 933
Manila, Philippines

J. S. Verma
Dept. of Plant Breeding
G. B. Pant University of Agric. & Tech.
Pantnagar, Nainital-263 145
INDIA 26314-5

Ric Vogel
Fruen Milling Co.
301 Thomas Ave.
Minneapolis, MN 55406

I. Wahl
Dept. of Botany
Tel Aviv University
Tel Aviv Ramat-Aviv
69978 ISRAEL

Harold Walter
Muhlenwerke am Hafen
d-2200 Elmshorn
WEST GERMANY

Mike Walter
Box 15003
Commerce Station
Minneapolis, MN 55415

Ted Walter
Agronomy Dept.
Throckmorton Hall
Kansas State University
Manhattan, KS 66506

Dr. S. H. Weaver
The Quaker Oats Company
P. O. Box 9001
Chicago, IL 60654-9001

Dr. Fran Webster
The Quaker Oats Company
617 West Main Street
Barrington, IL 60010

Dr. J. A. Webster
USDA-ARS Plant Science Res. Lab.
1301 N. Western St.
Stillwater, OK 74075

R. W. Welch
Biology Department
15G09, Univ. of Ulster
Jordanstown, Newtownabbey, BT370QB
UNITED KINGDOM

Dr. D. M. Wesenberg
Research & Extension Center
P O Box AA
Aberdeen, ID 83210

Trevor West
Weed Research Dept.
Long Ashton Research Station
Long Ashton, Bristol
BS 18 9 AF ENGLAND

D. E. Western
3365 Spring Mill Circle
Sarasota, FL 34239

Gerhard Wilbert
Cabec Intl Corp.
1607 - 116th Ave. N.E., Suite 105
Bellevue, WA 98004

Dr. Roy Wilcoxson
Dept. of Plant Pathology
495 Borlaug Hall
Univesity of Minnesota
St. Paul, MN 55108

Curtis Williams
Hartz Seed Co.
P. O. Box 946
Stuttgart, AR 72160

H. T. Williams
A & R Scott
Cupar
Fife SCOTLAND

David Wilson
Crop Improvement Division
Welsh Plant Breeding Stn
Plas Gogerddan, Aberystwyth
DYFED SY23 3EB, UNITED KINGDOM

Ralph Woodhull
617 W. Main St.
Barrington, IL 60010

David Worrall
P. O. Box 1658
Texas Ag. Experiment Station
Vernon, TX 76384

Ing. K. P. Wouda
Semundo B.V. Postbus 2
9970 AA Ulrum (Gr.)
THE NETHERLANDS

D. S. C. Wright
Crop Research Div., Cereal Section
D S I R Private Bag
Christchurch, NEW ZEALAND

G. M. Wright
33 Harakeke St.
Christchurch, NEW ZEALAND

Victor Wu
USDA
Northern Regional Research Center
1815 N. University
Peoria, IL 61604

Hirofumi Yamaguchi
Snow Brand Seed Co. Ltd. p
Chiba Research Station
631 Naganumahara-cho
Chiba City, Chiba Pref. 281 JAPAN

Gary L. Yarrow
The Quaker Oats Company
John Stuart Res. Center
617 West Main St.
Barrington, IL 60010

Lee R. Young
617 West Main St.
Barrington, IL 60010

Dr. V. L. Youngs
Dept. of Cereal Technology
North Dakota State University
Fargo, ND 58105

Dr. S. N. Zadoo
Div. of Plant Improvement
Indian Grassland & Fodder Res. Inst.
Jhansi 284003
INDIA

F. J. Zeller
Technische Universitat Munchen
805 Freising-Weihenstephan
WEST GERMANY

Dr. Alberto Zuloaga-Albarran
Apartado Postal No. 10
56230 Chapingo, MEXICO
421-88