1994

OAT NEWSLETTER

VOLUME 42

NOVEMBER 1994

Edited by Local Arrangements Committee
1994 American Oat Workers Conference, Minneapolis, MN
Publication Funded by American Oat Association

1994

OAT NEWSLETTER

VOLUME 42

Edited by the Local Arrangements Committee,
1994
American Oat Workers Conference
Minneapolis, MN
Publication Funded by American Oat Association

November 1994

TABLE OF CONTENTS

INSTRUCTIONS FOR OAT NEWSLETTER, VOLUME 43 TO BE PUBLISHED IN 1995

ATTENTION: Persons involved in any aspect of the oat industry and research including production and breeding, pathology, milling and processing, and biotechnology are encouraged to contribute to the 1995 Oat Newsletter.

Contribution to Volume 43 should be mailed to:

Herbert Ohm
Department of Agronomy
1150 Lilly Hall of Life Sciences
Purdue University
West Lafayette, IN 47907-1150

Contributions for the 1995 Oat Newsletter may be sent at any time but must be received no later than 15 February 1995.

Minutes of the American Oat Workers Conference Business Meeting
June 22, 1994. Minneapolis, Minnesota

The meeting was called to order by Greg Shaner, chairman.

(1) The minutes of the last meeting of the AOWC, at Jackson Hole, Wyoming, 1990, were accepted as circulated in the Oat Newsletter.

(2) Vth International Oat Conference

Brian Rossnagel reported on organizational activities for the Vth International Oat Conference which will be held jointly with the VIIth International Barley Genetics Symposium at Saskatoon, Canada from July 30 through August 8, 1996. Everyone was invited to attend. Initial announcement mailings will go out later this summer.

(3) Site Selection Committee, 1998 AOWC

James Chong extended an invitation on behalf of the oat R & D group at Agriculture Canada, Winnipeg to host the 1998 AOWC. The invitation was unanimously accepted.

(4) Oat Newsletter - Herb Ohm reported

An NOIC proposal has been made to the American Oat Association (AOA) that would have the AOA responsible for the production and distribution of the Oat Newsletter. The AOA has accepted the proposal.

Herb Ohm moved and Deon Stuthman seconded that the AOWC supports the NOIC proposal that an edited, camera-ready copy of the Oat Newsletter be submitted annually to the AOA and that the AOA provides printing and mailing costs. The motion carried.

Herb Ohm moved and Charles Murphy seconded that an Oat Newsletter Editorial Committee be appointed by the AOWC chair; that terms be four years, renewable; and that the Editorial Committee consist of one person from industry and three oat researchers. The motion carried.

(5) Standing Committees

(a) Awards - Committee chair Dave Peterson reported for the Distinguished Service to Oats Awards Committee at the AOWC Banquet June 21, 1994, in the form of presentation of awards to Vern Burrows, Robert Forsberg, and Harold Marshall.
(b) Committee for Nomenclature and Cataloguing of Oat Genes - chair Doug Brown. No activity to report.

Bob Forsberg moved and Mark Sorrels seconded that the AOWC recommend to the International Oat Conference (IOC) that the IOC assume responsibility for Gene Nomenclature and Cataloguing. The motion carried.

(c) Nominations committee

(1) Herb Ohm moved and Bruce Roskens seconded that the AOWC initiate a new office - Chair Elect - with progression from that office to chair. The motion carried.

(2) Herb Ohm moved and Charlie Brown seconded that the following slate of officers proposed by the Nominations Committee be elected for the four years 1994/95-1997/98:

Chair - Brian Rossnagel
Chair-elect - Fred Kolb
Secretary - Howard Rines
Members at Large - Dale Reeves, Dave Goslin, Darrell Wesenberg

(6) Oat Workers Code of Ethics - Bob Forsberg reported.
Bob Forsberg moved and Sam Weaver seconded that the AOWC accept the proposed Code of Ethics with a change to the title specifying the AOWC and an addition to cover the use of germplasm in the development of somaclones. (Note: The approved Code of Ethics is printed elsewhere in this Newsletter.)

(7) Resolutions Committee - chair Milt McDaniel

#1 Whereas this has been a most successful and enjoyable American Oat Workers' Conference, and whereas this success has been largely due to the excellent organization provided by our hosts; therefore be if Resolved that the Conference participants express their sincere appreciation to the staff from the oat program at the University of Minnesota and in particular to Deon Stuthman, Gary Fulcher and Howard Rines, and to Pat Henderson of the American Oat Association.

#2 Whereas General Mills Inc., The Quaker Oats Co., the American Oat Association, and the Crop Improvement Associations of North Dakota, South Dakota, and Wisconsin have provided generous financial support to this Conference; therefore, be it Resolved that the Conference participants gratefully acknowledge these contributions.

#3 Whereas Dr. Greg Shaner has faithfully served the American Oat Workers' Conference as Chairman for the past four years, be it Resolved that the members of the AOWC extended their sincere appreciation for his leadership during that period.

#4 Whereas Dr. Mike McMullen has served as the Editor of the Oat Newsletter for the past several years, be it Resolved that the AOWC extend their sincere thanks to Mike for his exemplary efforts in that task. In addition be it Resolved that the AOWC also extend sincere thanks to the Quaker Oats Co. for their financial support in the production and distribution of the Oat Newsletter.

(8) It was agreed that a letter of thanks be forwarded to the Quaker Oats Co. in appreciation of their support for the Oat Newsletter in the past.

(9) The meeting was adjourned at 1:25 p.m.

Reported by

AOWC Secretary
B. Rossnagel

A Statement of the Purpose of Organization of the American Oat Workers Conference

This statement shall serve to delineate the purpose and organizational structure of an American Oat Workers Conference. This Conference shall be made up of scientists and other workers actively engaged in the improvement, management, and utilization of oats. These requirements being met, active participation in the Conference constitutes membership, and all attending members at a particular meeting of the Conference shall have voice and vote in all matters properly brought before the Conference during a regular business meeting to be held during each meeting of the Conference. The Conference shall meet at a time, generally every four years, and at a location to be selected by vote of the attending membership at the previous meeting of the Conference. The Executive Committee, described below, shall have the authority to call emergency meetings of the Conference as necessary.

The purpose of the American Oat Workers Conference shall be to advance oat improvement and culture in the North America and the World by providing a vehicle for:

1. The dissemination of information on current research
2. The discussion of regional and continental problems of oat improvement and integration of applicable research
3. Encouraging the exchange and preservation of germplasm
4. Standardization of data recording and terminology
5. Planning regional and continental performance nurseries as appropriate
6. Preliminary announcements of planned cultivar releases
7. Action on other matters that may properly come before the Conference

Organization

American Oat Workers Conference Committee

The American Oat Workers Conference shall be under the general leadership of an American Oat Workers Conference Committee composed of official representatives of the various regions and countries and of a general Executive Committee. Members of the Executive Committee shall be the Chairman, Chair-Elect, Past Chairman, and Secretary of the American Oat Workers Conference and the Editor of the Oat Newsletter, and they need not be official representatives of the American Oat Workers Conference Committee. The Executive Committee shall appoint a nominating committee for a slate of officers for the offices of Chairman and Secretary of the Conference. The Chairman-elect and Secretary shall be elected by the membership of the Conference during the regular business meeting to be held each time the Conference meets. The term of office shall be four years and the Chairman, Chairman-elect and Secretary will assume their duties immediately after adjournment of the Conference wherein elected. The Chairman-elect will automatically become the Chairman for the ensuing four year period. These officers may serve consecutive terms if properly elected by the Conference. The Editor of the Oat Newsletter shall be appointed by the Executive Committee. The Editor of the Oat Newsletter may serve consecutive terms. It shall be the responsibility of the Executive committee to appoint an Acting Editor of the Oat Newsletter should that position be vacated between regular Conference meetings. The Past Chairman, Secretary and Editor of the Newsletter shall be non-voting members of the American Oat Workers Conference unless

they are also serving as representatives on the American Oat Workers Conference Committee. The Chairman shall be a voting member of the latter Committee and shall preside over all business meetings of the Committee and of the American Oat Workers Conference.

The American Oat Workers Conference shall be made up of official representatives from the various countries and regions as follows:

	Country and number of representatives		
Region or Agency	USA	Canada	Mexico
Northeastern Region	1	1	-
North Central Region	1	-	-
Western Region	1	1	-
Southern Region	1	-	1
Federal Dept. of Agric. Advisor	1	1	-

Where the representative cannot attend an official conference, he may designate an alternate.

In addition to the above minimum representation, three representatives shall be elected at large by the Conference during the regular meeting once every four years. Also, the elected chairman of the Conference shall be a member of the Committee. Thus, the total voting membership of the committee shall not exceed 14. Representatives from the various regions shall be selected by one of the following methods:

1. U.S.A. regional representatives normally shall be elected by the appropriate Regional Committee. In the event no such committee exists, the Secretary of the Conference shall contact oat workers within the region by mail once every four years and solicit nominations for a representative and subsequently conduct an election by mail ballot. The individual receiving the most votes shall serve as representative.

2. Canadian regional representatives shall be elected by: Western: the Barley and Oat Subcommittee of the Prairie Regional Registration Committee for Grain; Eastern: the Eastern Expert Committee on Cereals and Oilseeds. These groups will have the option of electing the third representative to fill the designated Federal position or of requesting Federal representation; whichever is more appropriate.

3. The representative from the U.S. Department of Agriculture shall be the national technical advisor for oat improvement.

4. The Mexican representative shall be designated by the appropriate government official or organization.

Alternates may be elected or appointed for each representative on the American Oat Workers Conference Committee.

Standing Committees

There shall be standing committees of the American Oat Workers Conference as follows:

1. Committee on Nomenclature and Cataloguing of Oat Genes

This committee shall consist of three conference members appointed by the chairman of the American Oat Workers Conference. It shall serve to assign symbols and catalog new genes governing characters in oats. Such genes will be listed and described in the Oat Newsletter on an annual basis. The committee will also be responsible for considering periodical up-dating and revision of the original publication on the subject, which was entitled "A Standardized System of Nomen-clature for Genes Governing Characters of Oats". There shall be no limit of office of committee members.

2. Nomination Committee for Distinguished Service to Oat Improvement Award.

This committee shall consist of three Conference members appointed by the Chairman of the American Oat Workers Conference and shall include at least two members who have served on the American Oat Workers Conference Committee. Their term of office shall be from date of appointment until the end of the following Conference meeting.

Oat Newsletter

The American Oat Workers Conference shall sponsor an Oat Newsletter to be published on an annual basis for the purpose of dissemination of information on current oat research and research needs. Members of the Conference are encouraged to submit information about their current research programs in response to an annual request to be made by the Editor of the Oat Newsletter. The newsletter shall also serve as a vehicle of publication for the minutes of the business meetings of the Conference and of the American Oat Workers Conference Committee as well as for committee reports and other Conference notes. Abstracts of papers presented at meetings of the Conference also shall be published in the appropriate issues of the Newsletter.

Contributions from countries outside the Conference will be accepted for inclusion in the Newsletter, and should be encouraged so as to promote the dissemination of oat research information and news.

The Oat Newsletter shall be distributed to all members of the Conference and upon request, to other interested oat and cereal crops workers outside the American Oat Workers Conference. The American Oat Association in conjunction with the Editor of the Newsletter shall maintain a mailing list for this purpose and publish it in each Oat Newsletter. An Oat Newsletter Editorial Committee of four (three researchers and one industry rep) is to be appointed by the AOWC Chair.

Distinguished Service to Oat Improvement Award

The American Oat Workers Conference shall confer the "Distinguished Service to Oat

Improvement Award" upon persons in recognition of their outstanding research contributions and/or meritorious service toward making oats a successful agricultural species. The recipient(s) of this award shall be nominated by the Committee previously described as having this charge, and they shall be elected for the award by a majority vote of the American Oat Workers Conference Committee. No restriction shall be placed upon whom may receive the award. However, as a general guide, the award should be presented to persons who have devoted a significant portion of their professional career and a significant number of years working with oats through research, extension, or other professional activities, The number of recipients should not be limited, but in general, not more than one to three persons would be recognized at one Conference meeting.

The award shall be conferred at a regular meeting of the American Oat Workers Conference. Manifestation of the award shall be denoted by the presentation of a suitable plaque or certificate to the recipient. A brief (not to exceed two typewritten pages) statement about the recipient and a photograph of the recipient shall be printed in the first volume of the Oat Newsletter after the presentation.

American Oat Workers Code of Ethics for Germplasm Exchange

Preamble

In past decades, oat workers worldwide have generously shared their oat germplasm with colleagues to enhance oat breeding and research. However, plant variety protection and patent mechanisms focus attention on proprietary rights afforded developers/owners of germplasm materials. The purpose of this code is to encourage the continued exchange of oat germplasm by recognizing these rights and by codifying the obligations of persons receiving unreleased oat germplasm. I therefore agree to support the following principles:

Code

1. The originating breeder, station, or company has property rights to unreleased oat germplasm such as pure lines, early generation lines or populations, bulk populations, breeding stocks, or genetic stocks. These rights are not waived with the distribution of seeds or plants of any of these unreleased materials. In this context, "released" materials include named cultivars or breeding or genetic stocks described in an official statement of release.

2. The owner/breeder, in distributing seeds or plant materials of unreleased oat germplasm, grants permission for their use (1) in performance tests under the recipient's control, such as the USDA Uniform Early and Uniform Midseason Oat Performance Nurseries, the Eastern or Western Canadian Cooperative Pre-registration Trials, or any national or international oat disease nurseries, and (2) as parents for making crosses for use in basic research or for selection leading to the development of cultivars. Uses of unreleased germplasm for which written approval from the owner/breeder is required include: selecting from the stock; induction of mutations through tissue culture or other means; insertion of recombinant DNA; use in backcrosses for addition of a gene(s) controlling a specific trait; testing in outlying nurseries not coordinated by USDA or Agriculture Canada; use as parents in commercial F_1 hybrids or as components in synthetic or multiline cultivars; or seed increase and release as a cultivar.

3. The recipient of unreleased seeds or plant material shall make no secondary distribution of the germplasm without the permission of the owner/breeder.

4. The recipient of unreleased materials shall take precautions to prevent unauthorized transfer or theft of seed of these materials from nurseries or seed inventories.

5. The owner/breeder of unreleased oat germplasm stocks may waive, in writing, any of the above restrictions, or may impose additional restrictions.

6. Retention and use of the germplasm accompanying this statement indicates your agreement with the policies set forth in this statement.

This statement was approved by the members of the American Oat Workers Conference, Minneapolis, Minnesota on June 22, 1994.

Minutes of the NOIC meeting, 22 June 1994

Chairman Herb Ohm called the meeting to order at 1:30 PM.

Items of Business:

1. Oat Crop Advisory Committee. Dr. Robert Forsberg has retired and needs to be replaced on the committee. Also, the committee is small and the number of members should be increased to have broad representation of the oat community. Current members of the committee are Mike McMullen, Dave Peterson, Sam Weaver, Harold Bockelman, Chuck Murphy, Darrell Wesenberg, and Greg Shaner (Chm). Fred Kolb, Paul Murphy and Pam White have agreed to serve on the Committee beginning in 1994.

The Oat Crop Advisory Committee is discussing a defined term of appointment and a rotational system to replace members on a scheduled basis to maintain continuity on the committee.

2. AOA Research Committee

See the Report of the AOA Research Committee in this Newsletter.

3. A meeting of the NOIC is scheduled to take place during the American Society of Agronomy Meetings at Seattle, Washington on Monday evening, 14 November 1994 at 7:30 PM, room to be announced in the Program for the American Society of Agronomy Meetings. The primary agenda item is discussion of agenda items for the AOA Research Committee.

4. By consensus, the NOIC wishes to recognize Dr. Darrell Wesenberg for his many research collaborations and coordination with other oat researchers.

Respectfully submitted,
Herb Ohm

Report of AOA Research Committee visit to Washington, DC, February 7 to 9, 1994

Committee members John Bollingberg, Pat Henderson, Mike McMullen, Paul Murphy, Herb Ohm, Deon Stuthman, and Sam Weaver visited with staff members of selected Senate and House of Representatives Congressional members of the Senate and House Ag Appropriations Committees, and Office of Management and Budget personnel as well as Dr. Dean Plowman, Acting Assistant Secretary, USDA, and several USDA-ARS National Program Staff to discuss national agriculture program policy issues that impact oat production and specific oat research support needs. Data were presented showing increasing importation of oats since 1984 to meet US national utilization needs for oats for food and feed. Factors that contributed to the need to import 29% of oats utilized in 1989, 31% in 1992, and 46% or 95 million bushels in 1994 were discussed. It was pointed out that oat is the only cereal grain that is net imported to meet domestic needs.

Justifications were discussed for three new USDA-ARS research positions to meet oat improvement research needs at the national level, as outlined in the National Plan for Oat Research. Specifically, salary and research program support for a Small Grains Pathologist position at Raleigh, North Carolina (also supported by the National Wheat Improvement Council), a new Rust Research position at the Cereal Rust Laboratory, St. Paul (also supported by the wheat and barley groups), and an Oat Molecular Cytogenetics position at St. Paul were presented as national needs for oat improvement. The AOA Research Committee perceives that our concerns were well received and that with continued persistence, support for these positions may be forthcoming.

The committee discussed positive impacts and roles of oats in rotation, as a companion crop, and its positive potential in various environmental issues related to intensive crop production, and the need for additional research in these areas.

The committee also visited with representatives of the National Grain and Feed Association, the Wallace Institute, and others to discuss various issues relating to oat research needs, marketing, and environmental issues relating to crop production.

Subsequent to our visit to Washington, DC in February, Pat Henderson, Sam Weaver and Herb Ohm arranged phone conversations with wheat and barley representatives to explore areas of common research needs, and crop production and utililization concerns. Hopefully, these interactions will continue so that the cereal commodity representatives can present a coordinated and complementary agenda in areas of common interest for future visits to Washington, DC.

Herb Ohm
Chairman, AOA Research Committee

MINUTES OF THE BIENNIAL MEETING
OF NCR-15 OAT IMPROVEMENT
MINNEAPOLIS, MINNESOTA
JUNE 20, 1994

The biennial meeting of NCR-15 was called to order at the Sheraton Minneapolis Metrodome Hotel, Minneapolis, Minnesota by chair Rob Gooding. Experiment station representatives in attendance were:

Fred Kolb	Illinois AES
Herb Ohm	Indiana AES
Ken Frey	Iowa AES
Deon Stuthman	Minnesota AES
Mike McMullen	North Dakota AES
Rob Gooding	Ohio AES
Dale Reeves	South Dakota AES

Also in attendance were: Signe Betsinger, Minnesota AES; Charles Brown, Univ. of Illinois; Bob Forsberg, Univ. of Wisconsin; Jim Holland, North Carolina State Univ.; Stephen Harrison, Louisiana State Univ.; David Peterson, Univ. of Wisconsin/USDA-ARS; Howard Rines, Univ. of Minnesota/USDA-ARS; Greg Shaner, Purdue Univ.; and Sam Weaver, The Quaker Oats Co.

Next meeting of NCR-15. Time and place for the next NCR-15 meeting was discussed. It was decided to hold the next meeting in conjunction with the International Oat Workers Conference in Saskatoon, Saskatchewan, Canada. The meetings are scheduled for August 1-8, 1996.

NCR-15 Oat Workers' Field Day. In Mike McMullen's absence, it was suggested that the 1995 Oat Workers' Field Day be held at the North Dakota Agricultural Experiment Station. Upon his arrival at the meeting, Mike extended an invitation to hold the 1995 NCR-15 Field Day at Fargo, ND. Time of the field day remains pending, but will probably be around July 10, 1995.

Progress of NCR-15 extension application. There was some confusion regarding the term of authorization for NCR-15. Although it was reported in the minutes of the 1992 meeting to be through September 30, 1996, it was determined that authorization expires on September 30, 1995. Application for extension of NCR-15 should therefore be completed before the next Agriculture Experiment Station Directors' meeting, in July, 1995. The elected chair of NCR-15 appointed for the 1994-1996 term is Ann McKendry; however she may not be directly involved in oat research at that time. Rob Gooding volunteered to see that the application is completed if Ann is unable to do so.

Fred Kolb suggested that each member of NCR-15 write a letter to their agriculture experiment station director regarding the importance of NCR-15 to oat research. This would help the directors become familiar with the importance of NCR-15 before deciding on its continuance. Fred also suggested that copies of such letters be sent to Rob Gooding. Rob stated that a reminder will be sent to all members of NCR-15 in May or June, 1995 and that letters should be sent to the experiment station directors by July, 1995, to coincide with their meetings.

Election of Officers. Because Ann McKendry may not be able to assume duties as chair of NCR-15, Rob Gooding volunteered to continue on as chair through the 1994-1996 term if necessary. Jim Holland was nominated and elected unanimously as secretary for the 1994-1996 term. He will assume the duties of Chair during the 1996-1998 term.

Uniform Early and Midseason Oat Performance Nurseries. During the 1992 meeting, it was decided to include 'Prairie' as a check in the midseason nursery. Howard Rines reported that Prairie has not performed up to expectations, however, and suggested that it be replaced with 'Troy' in future nurseries. This suggestion was accepted unanimously.

The Plant Breeders' Policy of Ethics was discussed. This policy states that any materials entered into the uniform nurseries can be used by other breeders as a crossing parent, but not as a recurrent parent for backcrossing or transformation. This policy was accepted by all in attendance.

The possibility of screening the uniform nursery entries for β-glucan content was discussed. Dave Peterson suggested that his lab could evaluate grain from each entry in the nurseries collected at 3-4 locations. His data indicate that β-glucan levels are reasonably stable across environments, so evaluating grain from every location is probably not necessary. At this point he has screened 6000 oat accessions from the USDA small grains collection, and the data are available through GRIN. Fourteen thousand accessions remain to be screened. Charles Brown suggested that the uniform nurseries constituted a higher priority for β-glucan screening than the remaining germplasm collections. It was agreed by all that screening grain from all uniform nursery entries from 3-4 locations for β-glucan content was of highest priority.

Strategic Plan for Oat Research in the NCR. At the 1992 meeting of NCR-15, it was decided to update the Strategic Plan for Oat Research in the NCR. The plan should define objectives and cooperation among states in the NCR for oat research to best use available resources and avoid duplication of efforts. The committee responsible for the update consists of:

Mike McMullen....Chair
Dave Peterson....USDA
Sam Weaver.....Industry
Greg Shaner.....American Oat Workers' Conference
Mike Lee.....Biotechnology
Gary Fulcher.....Nutrition

The committee hopes to finish its work by the end of summer of this year. Mike McMullen outlined the changes that were being considered in the plan that was originally formed in 1988:

1. Reduction in competitiveness of domestic oats needs to be addressed.
2. Computer networking should be used to increase communication and efficiency among researchers.
3. The loss of faculty positions related to oat research needs to be highlighted and addressed.

Thanks to Deon Stuthman, Howard Rines, Gary Fulcher, and others at the University of Minnesota. Rob Gooding, on behalf of the NCR-15 Oat Improvement Committee, expressed his appreciation to Deon, Howard, Gary, and their students and colleagues at the University of Minnesota for their gracious hospitality and their hard work in organizing the 1994 American Oat Workers' Conference.

Additional Business. Preston Jones sent greetings from the Cooperative State Research System via Signe Betsinger, who is now the administrative advisor to NCR-15.

Russell Freed from Michigan State Univ. sent word via Sam Weaver that he has moved to Department Chair and will no longer be active in oat research, but he has offered to continue to grow the uniform nurseries and carry out cooperative testing.

Stephen Harrison offered to screen breeding materials from NCR at his nursery in Louisiana, where rust disease pressure is severe. He hopes to have this work funded by The Quaker Oats Co. Currently, he grows and rates head row plots for Fred Kolb in Baton Rouge,

where there exist tremendous crown and stem rust pressures. He could handle about 200 entries from each breeder in the NCR. Bob Forsberg suggested that screening the uniform nursery materials would be more helpful than earlier generation breeding materials. Stephen agreed to screen the nurseries, and would also accept additional materials from individual breeders. Possible planting dates are in January.

Deon Stuthman reminded breeders that the New Zealand off-season nursery is still available for use by members of NCR-15.

Ken Frey stated that he had a complete set of notes for meetings of NCR-15 dating back to circa 1950.

Signe Betsinger mentioned that she has scientific contacts in Eastern Europe, and that donations of scientific books and journals or contacts by other American scientists with East European scientists are greatly needed.

Steven Benzinger, Univ. of Nebraska, sent a letter stating that he appreciated the invitation to the NCR-15 meeting, but that he could not attend due to research conflicts. He hopes to attend in the future.

State Reports. State reports were presented from Illinois, Indiana, Iowa, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Reports included information on acreage, production, growing conditions in 1993, personnel changes, and variety and germplasm releases. In general, it was reported that 1993 was a poor year for oat production, due to excessive moisture, although North Dakota had a record year for high yields. Severe rust problems were reported. The oat breeding program at Ohio suffered severe budget cuts, and will operate with limited resources in the future.

A motion to end the meeting carried, and the meeting was adjourned.

Respectfully submitted,

10/19/94

Robert W. Gooding,
Chair

James B. Holland,
Acting Secretary

Signe T. Betsinger 10/07/94

Signe T. Betsinger,
Administrative Advisor

AWARDS FOR DISTINGUISHED SERVICE TO OAT IMPROVEMENT

At the 1966 meeting of the National Oat Conference in East Lansing, Michigan, a decision was made to honor selected persons in "recognition of their outstanding research contributions and/or meritorious service toward making oats a successful agricultural crop species." (See 1966 Oat Newsletter 17:1-2.)

People who were awarded this honor in the past were: I.M. Atkins, C. M. Brown, R. M. Caldwell, F.A. Coffman, H.F. Harrison, H.K. Hayes, G.K. Middleton, D.E. Western, O.T. Bonnett, M.B. Moore, H.L. Shands, J.E. Grafius, N.F. Jensen, J.M. Poehlman, F.L. Patterson, T. Rajhathy, K.J. Frey, D. J. Schrickel, and M.D. Simons.

At the 1994 meeting of the American Oat Workers Conference held in Minneapolis, MN, three people were chosen in accordance with Conference procedures. Photographs and biographies of those selected to receive the award for Distinguished Service to Oat Improvement at the 1994 meeting follow.

Vernon Douglas Burrows

Dr. Vernon Burrows was born in Winnipeg, Manitoba and graduated from the University of Manitoba with a BSA degree (1951) and a MSc degree (1953). He specialized in genetics and plant breeding but developed a strong interest in plant physiology and biochemistry. He obtained a PhD degree in biology (1958) from the California Institute of Technology specializing in physiology and plant biochemistry. After graduation he was employed by the Canadian Department of Agriculture and was stationed at Ottawa. He worked as a physiologist on oats with the oat breeder Dr. Frank Zillinsky until Frank left to work with Dr. Norman Borlaug at CIMMYT in Mexico. Vern was then asked to assume responsibility for the oat program at Ottawa. This gave him the opportunity to apply his knowledge in genetics, plant breeding, physiology and biochemistry to breeding new oat varieties primarily for eastern Canada.

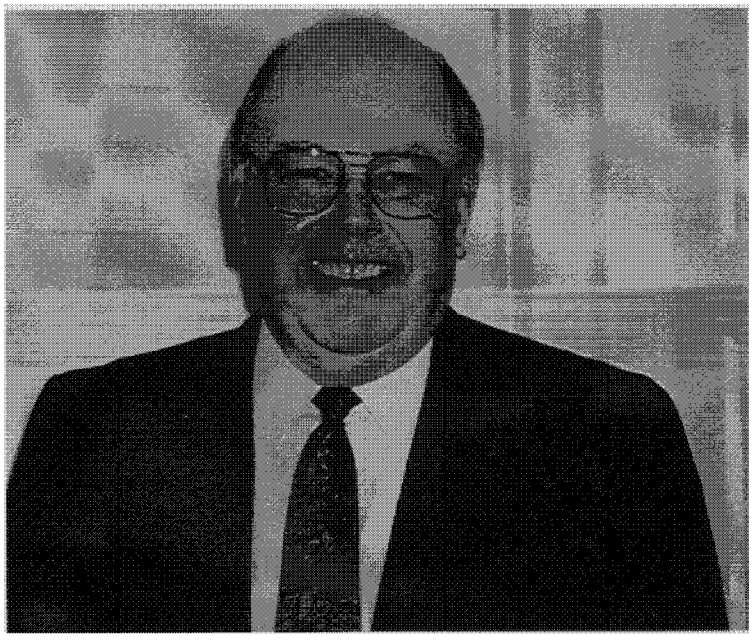
Throughout his career he has attempted to increase the popularity of oats by improving their usefulness for food, feed and industrial purposes. During his career he has bred and registered 9 covered-seeded varieties, Scott (1972), Gemini (1973), Hinoat (1973), Sentinel (1978), Foothill (1978), Donald (1982), Newman (1988), AC Stewart (1991) and AC Hunter (1993), and 5 naked-seeded varieties, Tibor (1985), AC Lotta (1991), AC Hill (1991), AC Percy 1992) and AC Baton (1994). He also developed the concept and experimental strains of "dormoats" which combine the seed dormancy genes from wild oats (*Avena fatua* L.) with the desirable genes from the best commercial varieties of domestic oats. Dormoat remains an experimental crop in Canada but it shows promise as a crop to meet the specifications of sustainable agriculture especially for marginal soils.

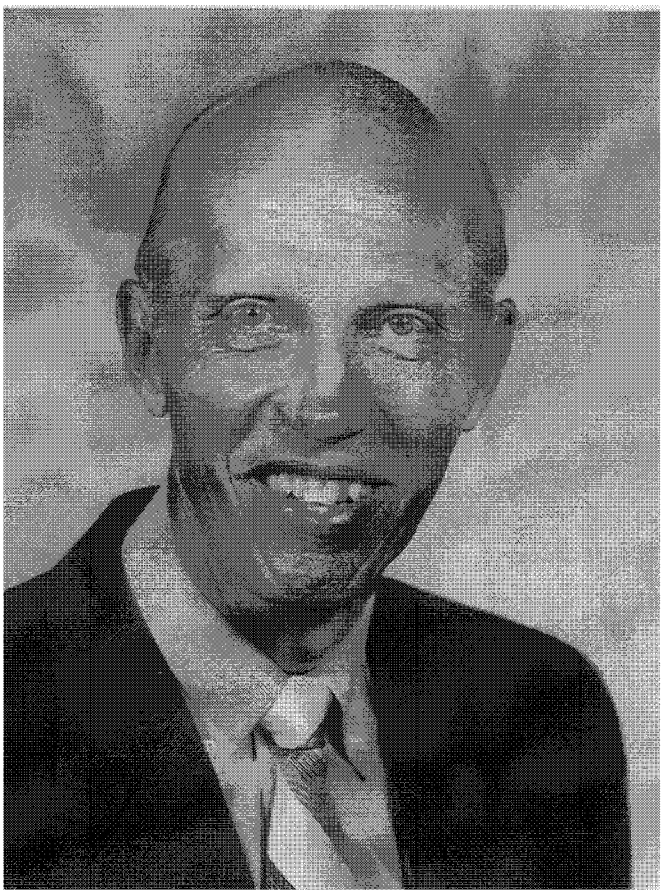
Dr. Burrows has accomplished several firsts in his oat improvement program. He was able to select and commercialize three quite different varieties (Gemini, Hinoat and Foothill) from Frank Zillinsky's interspecific (*A. sativa* x *A. strigosa*[2]) breeding program. Hinoat was Canada's first high protein oat that was grown under contract for General Foods to make the first high protein pre-sweetened breakfast cereal. The variety has also served as a model plant for researchers to study storage protein synthesis in oat. Foothill was Canada's first forage-type oat which is now being grown in Alberta (138,000 acres in 1993) and large seed exports are marketed in Pacific rim countries. Donald was Canada's first daylength insensitive milling-type oat possessing the Di-1 gene derived by Vern from an *A. byzantina* accession from Turkey. This gene was used by Burrows to establish a "shuttle" breeding oat program between Ottawa in summer and California in winter. Donald and the related variety Newman have helped develop an oat milling industry in Ontario. The naked varieties AC Lotta and AC Baton also are insensitive meaning high quality "ready to eat" nutritious oats can be grown in most grain growing regions of the world.

Burrows worked diligently to breed superior naked oat varieties. He concluded that in spite of all the effort breeders have devoted to breeding excellent covered-seeded varieties, oat acreages in the world have declined steadily. When the work horse was replaced by petroleum power, the oat hull prevented the covered oat from finding new animal clients to serve. The proper use of hull-less genes results in harvested groats that combine, in the one grain, the metabolizable energy equivalent to corn with enough high quality protein for most pig and poultry diets. Substitution of the oat groat in animal diets for the warm seasoned crops corn and soybean is attractive to farmers in the cooler regions of Canada to reduce transportation and feed costs.

Burrows has cooperated with industrial partners such as General Foods, Dupont of Canada, Quaker Oats, Robin Hood Multifoods and UFL Foods of Canada on specific projects to improve the usefulness of oats. While working on a project to induce secondary dormancy in dormoats, he discovered a water steeping process that could be used to fractionate oat into flour, bran and aqueous components. Working with Drs. R.G. Fulcher, D. Paton and F.W. Collins, patents were obtained which has led to the construction of a processing plant in Saskatoon by Canamino Inc. to process oats for the cosmetic and food trade. Dr. D. Paton, now at the Saskatoon Research Station, Agriculture Canada, played a very major role and was the motive force behind the patenting and commercialization of this industrial process.

Burrows has contributed much to the oat scientific literature and to the development of genetic stocks for specific traits. In addition he has authored three book chapters on oat breeding, the feeding of oats and on biotechnology and oat improvement. He has served on numerous committees dealing with oat and cereal improvement and has performed as a consultant on oats for the general and farm public, the scientific community, and food and industrial processors. For his contribution he was awarded the prestigious Grindley Medal by the Agricultural Institute of Canada (1975) and has received two certificates of recognition by Agriculture Canada. He was made a Honourary Life Member of the Canadian Seed Growers Association in 1986.





Robert A. Forsberg
Award for Distinguished Service to Oat Improvement

Dr. Robert A. Forsberg was affiliated with the small grain research and breeding programs at the University of Wisconsin-Madison for over 39 years. He was an undergraduate student worker during 1949-1952 (B.S.), a graduate student/project assistant during 1956-1961 (M.S. and Ph.D.), and a faculty member from 1963 until he retired in January 1994. He was a Postdoctoral Fellow at North Carolina State University during 1961-1963. Dr. H.L. Shands served as his mentor, advisor, and faculty colleague until Dr. Shands retired in 1974. During his 31-year tenure as a faculty member Dr. Forsberg taught courses in biometry, experimental design, biometrical procedures in plant breeding, and taxonomy and seed characteristics of crop plants. He served as Chairperson of the Department of Agronomy during 1979-1989, and he served on many college and campus committees.

Dr. Forsberg's major research and breeding efforts dealt with the transfer of genes for disease resistance from diploid and tetraploid oat species to cultivated hexaploids followed by incorporation of these genes into genotypes worth of release as cultivars such as Centennial (1983), Horicon (1989), Dane (1990), Bay (1993), and X5673-2 (1995). His oat research encompassed the cytogenetic and breeding behavior of 6x amphiploids, of monosomic alien substitution lines, of hexaploid translocation lines, and of octoploid lines, and their use in interploidy gene transfer programs; quantitative inheritance of panicle traits; inheritance of protein and lipid concentration; the genetics of physical physiological, and biochemical aspects of oat grain quality; and the possible role of 2n gametes in interploidy gene transfer and in the evolution of hexaploid oats. Dr. Forsberg, his graduate students, his technical support staff--especially Mr. Ron Duerst, and his colleague Dr. Marshall Brinkman--carried on breeding programs in oats, soft red winter wheat, barley, winter rye, and winter triticale, all of which resulted in the release of improved cultivars.

Dr. Forsberg was an active participant in national and international activities of the Crop Science Society of America and the American Society of Agronomy including several significant editorial and committee assignments. He was honored as a fellow of A.S.A. in 1985 and of C.S.S.A. in 1986. During 1989-1994 he also served as North American Editor of the Journal of Genetics and Breeding.

Dr. Forsberg was an active participant in many national and international oat organizations. He served as Chairperson of the American Oat Workers Conference (1978-1982), the U.S. National Oat Improvement Council (1978-1986), the North Central U.S. Regional Oat Workers Conference (NCR-15) (1979-1980), and of the Legislative Liaison Committee of the Milling Oats Improvement Association (now the American Oat Association) (1978-1985). He was a member of the U.S. Oat Crop Advisory Committee during 1978-1994, and he played significant roles in preparing the first (1987) and second (1992) editions of the U.S. "Strategic Plan for Oat Research" documents. He currently serves on the U.S. Secretary of Agriculture's Plant Variety Protection Advisory Board (1991-).

Internationally, Dr. Forsberg served as Chairperson of the International Oat Workers Conference during 1988-1992. Since 1990, he has been Wisconsin's representative on the Quaker Oats South American Oat Improvement Project working with Dr. S.H. Weaver (Quaker Oats), Dr. M.E. McDaniel (Texas A&M University), and Mr. Romulo Trombetta (Quaker South America).

Harold G. Marshall
Award for Distinguished Service to Oat Improvement

Dr. Marshall spent his entire professional career working on oat improvement for ARS-USDA, and was located in the Department of Agronomy at The Pennsylvania State University. He retired from ARS-USDA in 1987, but continues to do oat breeding in a private program at his farm near University Park, Pa. His research accomplishments are well documented in the literature though numerous journal articles and several book chapters.

Dr. Marshall was born May 7, 1928, and grew up on a hilly farm near Selvin in southern Indiana. His first memorable experience with oats was sowing a field of Forkedeer with a drill drawn by a three horse hitch on a very hot day and having his favorite horse drop dead. He grew up cutting oats with a horse drawn binder and worked in the community "threshing ring". After graduation from high school in a class of four boys, he attended Purdue University where he received his B.S. degree in Agronomy in 1952. He then moved on to Kansas State University as a graduate assistant on the wheat improvement project, married Barbara Parsons, and earned his M.S. degree under the direction of Dr. John Schmidt. During the summer of 1953, Dr. Marshall began working toward a Ph.D. degree at the University of Minnesota. That effort, however, was interrupted by a two year stint in the U.S. Army during the Korean conflict. He returned to the University of Minnesota in 1956 as a teaching assistant in genetics, cytogenetics, and plant breeding. His thesis research was with interspecific hybrids in oats under the direction of Dr. W. M. Myers, and he received his Ph. D. degree in the spring of 1959.

Dr. Marshall's initial ARS-USDA assignment at Penn State was to develop winter oat germplasm with improved levels of winter hardiness and to combine that complex trait with other desirable characteristics, frequently through introgression of winter and spring oat germplasm. He developed elite germplasm that was shared with other oat breeders through both formal and

informal releases. His most noteworthy cultivar is Pennwin which has a high level of winter hardiness combined with high yield potential and good lodging resistance. He developed a crown freezing technique that is precise enough to select individual plants with elite freezing resistance. One resulting line, Pennline 40, has winter hardiness well above the previous upper limit of that trait. Dr. Marshall also used the crown freezing technique to convert spring oat semidwarfs to winter types by backcrossing crown freeze survivors to the semidwarf. In addition to freeze-test technology, he also made substantial contributions to winter oat breeding methodology and to knowledge about changes in winter oat populations while under natural selection pressure for winter survival.

Starting in 1974, Dr. Marshall devoted part of his time to improvement of spring oat germplasm with particular emphasis on lodging resistance. That effort led to some of the most lodging resistant germplasm available, and his semidwarf germplasm is being used in several programs. He also developed Hercules, a tall, lodging resistant cultivar that is extensively grown in the Northeastern USA where straw yield is important but lodging is likely to be a serious problem. Dr. Marshall also is widely known for his work with naked-seeded oats and the development of Pennuda cultivar which has excellent groat characteristics, high protein, and exceptional lodging resistance. Development of Pennuda was cited before Congress as one of eight major ARS accomplishments during 1986. Dr. Marshall serves as coordinator of the Cooperative Naked Oat Test which he initiated in 1991. That test now is grown at 10 locations in the USA and one location in Canada, and has provided valuable information about the adaptation and productivity of current naked oat germplasms and about variation in the expression of the naked-seeded trait in different environments.

Dr. Marshall served as secretary of the American Oat Workers Conference during 1974-86. He was the primary author of the operating charter of the AOWC and served on many committees including the Legislative Subcommittee, the National Oat Improvement Council, and the task force that prepared the first National Oat Strategic Plan. In 1982, at The Pennsylvania State University, Dr. Marshall organized and hosted a joint meeting of AOWC and the First International Oat Conference. In addition to these activities, Dr. Marshall was coordinator of the various uniform regional winter oat nurseries from 1963 through 1987, National Technical Advisor for oat research from 1976 to 1981, chairman of the Oat Registration subcommittee of the Crop Science Society for many years, and ARS representative on the National Variety Review Board for several terms. He was sponsoring scientist, 1968-72, on PL-480 Project Israel which collected much valuable wild oat germplasm, ARS-USDA representative on the NCR-15 Regional Committee, 1976-80, and ARS-USDA member of a two man winter hardiness team that spent 6 weeks in the USSR during 1977.

Dr. Marshall is a member of Sigma Xi, Gamma Alpha Scientific Fraternity, Gamma Sigma Delta, and is a fellow of the American Society of Agonomy and the Crop Science Society of America. He has served on several major committees of the latter societies and as an associate editor of Crop Science. With able assistance from a co-editor and an editorial committee, he recently completed the gargantuan task of editing a new monograph, *Oat Science and Technology*.

Announcement for the V INTERNATIONAL OAT CONFERENCE and the
VII INTERNATIONAL BARLEY GENETICS SYMPOSIUM

The University of Saskatchewan, Saskatoon, Canada is pleased to host the VII Int'l. Barley Genetics Symposium and the V International Oat Conference from July 30 through August 8, 1996.

These meetings will be held at the University of Saskatchewan campus in Saskatoon with the Barley Symposium running from July 30 - August 6 and the Oat Conference running from August 1 - August 8. The meetings will have joint sessions from July 31 - August 6, including oral presentations, poster sessions, field tours and social events. A refereed proceedings of both conferences will be published.

Saskatoon is situated in the heart of western Canada's cereal production area which includes annual production of four million acres of oat and ten million acres of barley. The picturesque city of Saskatoon with a population of 180,000 is situated on the banks of the North Saskatchewan river and is known as the sunniest city in Canada and one of the friendliest conference hosting venues anywhere.

We look forward to hosting our many international colleagues and to an excellent set of joint meetings. For further information please contact Brian Rossnagel at the Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, S7N 0W0. FAX 306-966-5015 or EMAIL rossnagel@sask.usask.ca

1994

AMERICAN OAT WORKERS CONFERENCE

STATEMENT OF PURPOSE

This issue of the Oat Newsletter represents several changes. First, the American Oat Association (AOA) has assumed the financing of printing and distributing the Oat Newsletter. Previously, the financing has been borne solely by The Quaker Oats Company. We are grateful for their many years of sponsorship of this major contribution to the oat community.

With the AOA assuming the financing of the Newsletter, the format of the next volume will be expanded to include industry-wide communication, rather than issues aimed primarily at researchers. As a transition, this issue is a proceedings of the program and business meetings from the recent American Oat Workers Conference (AOWC) held in Minneapolis, in June 1994.

Given the expansion of the Newsletter and the increased effort required to assemble it, future editions will be assembled by an Editorial Committee rather than by a single individual. Dr. Mike McMullen has been responsible for both the assembly and the distribution for a number of years and we are grateful for his efforts over the years.

Finally, the local committee who organized the AOWC program wishes to express appreciation to all speakers who contributed to the program. We are especially grateful to those presenters who have not been a part of the group. These people enriched our program as we sought to provide information which was valuable to all aspects of the industry, thereby enhancing interaction among a diverse group of people. As our research group gets smaller in numbers, it is essential that we develop closer ties with others who are interested in the future of the North American oat crop.

D.D. Stuthman, Chairman
Local Arrangements Committee
1994 AOWC

1994 AMERICAN OAT WORKERS CONFERENCE

Sheraton Minneapolis Metrodome
Minneapolis, MN
June 19-22, 1994

Executive Committee

Chairman:	G.Shaner, Purdue University
Past Chairman:	H.W. Ohm
Secretary:	B. Rossnagel, University of Saskatchewan

Local Arrangements Committee

Chairman:	D.D. Stuthman, University of MN
	G. Fulcher, University of MN
	P. Henderson, American Oat Association
	H. Rines, USDA/ARS, St. Paul, MN

SPONSORS--1994 AMERICAN OAT WORKERS CONFERENCE

ND CROP IMPROVEMENT ASSOCIATION
SD CROP IMPROVEMENT ASSOCIATION
WI CROP IMPROVEMENT ASSOCIATION
GENERAL MILLS, INC.
THE QUAKER OATS CO.
AMERICAN OAT ASSOCIATION

Special Thanks to Jean Swanson, University of Minnesota, Department of Agronomy and Plant Genetics, St. Paul, MN

OATS FOR THE 21ST CENTURY • *DNA to the Dinnerplate*

SUNDAY, JUNE 19, 1994

4:00 pm — Registration Opens

6:45 pm — Depart for Harriet Island by Bus

7:30 pm — Opening Reception — Jonathan Padelford River Cruise, Mississippi River, St. Paul, MN, Cash bar

MONDAY, JUNE 20, 1994 • Salons C–D

7:30 am — **Registration**

8:10 am — **Welcoming Remarks**
M. Martin, Associate Dean, College of Agriculture, Forestry and Home Economics, University of MN and Assistant Director, MN Agricultural Experiment Station

8:20 am - 11:30 am — **MANAGING OATS AND PRODUCT QUALITY**
The Challenge
G. Fulcher, Food Science and Nutrition Department, University of MN, St. Paul, MN
Respondent Panel
Moderator, R. Lottie, Chairman American Oat Association Board of Directors and Manager, Cereal and Eastern Grain Operations, General Mills, Inc., Minneapolis, MN

8:30 am - 8:50 am — **Defining Quality**
B. Roskens, Manager, Crop Production and Development, The Quaker Oats Co., Chicago, IL

8:50 am - 9:30 am — **Producing and Handling Quality**
B. Rosnagel, Senior Research Scientist, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan
W. Hill, Manager, Western Feed Grains Division, United Grain Growers, Calgary, Alberta
M. Willette, Willette Seed Farm, Delavan, MN

9:30 am — **Break** • Foyer

9:45 am - 10:30 am — **Processing Quality**
W. Bonner, Director of Technical Services, Oat Milling Products, ConAgra Grain Processing Co., Omaha, NE
J. Heitweg, Production Manager and Process Engineer, General Mills, Inc., Fridley, MN

10:30 am - 10:50 am — **Novel Industrial Uses**
J. Schaw, President, Canamino, Inc., Saskatoon, Saskatchewan

10:50 - 11:15 am — **Discussion**

11:30 am - 1:00 pm — **Lunch**
Luncheon Presentation: **WHY GENETICALLY ENGINEER OATS?** R. Phillips, Regents' Professor, Department of Agronomy and Plant Genetics, University of MN, St. Paul, MN

1:15 pm - 3:00 pm — **GENETIC ENGINEERING/RESPONDENT PANEL**
Moderator, B. Rosnagel, Senior Research Scientist, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan

1:25 pm - 1:40 pm — **Food Processing Issues**
M. Dahl, Director of Research and Development, Malt-O-Meal Co., Northfield, MN

:40 pm - 1:55 pm — **Opportunities for Processors**
F. Webster, John Stuart Research Laboratories. The Quaker Oats Co., Barrington, IL

1:55 pm - 2:10 pm — **Production and Ecological Concerns**
R. Shaw, Department of Ecology, Evolution and Behavior, University of MN, St. Paul, MN

2:10 pm - 2:25 pm — **Who Benefits from Genetic Engineering?**
L. Busch, Department of Sociology, Michigan State University, East Lansing, MI

2:25 pm - 2:45 pm — **Discussion**

3:30 pm — **UNIVERSITY OF MN TOURS**
- Rust Lab
- Biotechnology Labs
- Cereal Quality Labs
- Field Plots, including Buckthorn

Dinner on your own

8:00 pm — **NCR–15 Business Meeting** • Natchez–New Orleans Room

TUESDAY, JUNE 21, 1994 • Salons C–D

8:00 am - 10:00 am — **OATS — THE ENVIRONMENTALLY FRIENDLY CROP**
Moderator, C. Fernholz, Producer, Madison, MN and Member of Institute for Sustainable Agriculture and American Oat Association Board of Directors

8:05 am - 8:20 am — **Sustainable Production Systems**
D. Wyse, Director, MN Institute for Sustainable Agriculture, St. Paul, MN

8:20 am - 8:35 am — **Rotations**
D. Wyse* and K. Crookston, Head, Department of Agronomy and Plant Genetics, University of MN, St. Paul, MN

8:35 am - 8:50 am — **Non-Grain Uses — Forage, Ground Cover, Dwarf/Companion Cropping**
S. Simmons, Department of Agronomy and Plant Genetics, University of MN, St. Paul, MN

* Presenter

8:50 am - 9:05 am — **Competition — Wild and Cultivated Oats**
B. Durgan, Extension Agronomist, University of MN, St. Paul, MN

9:05 am - 9:30 am — **Discussion**

10:00 am - 12 Noon — **POSTER SESSION** • Memphis Room

12 Noon - 1:30 pm — **Lunch** • Salons A–B
Luncheon Presentation: D. Schrickel, Consultant, Grain Crops, Phoenix, AZ
Slide Show Presentation: "Wild Oat Collection in Israel"

1:45 pm - 4:30 pm — **PEST MANAGEMENT**
Moderator, G. Shaner, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

1:55 pm - 2:15 pm — **Epidemiology of Crown Rust**
A. Roelfs, Plant Pathologist, USDA/ARS Cereal Rust Lab, St. Paul, MN

2:15 pm - 2:35 pm — **Molecular Markers and Partial Resistance to Plant Diseases**
N. Young, Department of Plant Pathology, University of MN, St. Paul, MN

2:35 pm - 3:00 pm — **OPEN DISCUSSION OF RUST RESISTANCE BREEDING STRATEGIES**

3:00 pm - 3:30 pm — **Break** • Foyer

3:30 pm - 3:50 pm — **Engineered Cross Protection Against BYDV**
R. Lister, J. Vincent* and P. McGrath, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

3:50 pm - 4:10 pm — **Variability and Strain Specificity of Resistance to BYDV**
S. Gray, Department of Plant Pathology, Cornell University, Ithaca, NY

4:10 pm - 4:30 pm — **Discussion**

6:00 pm — **Social Hour** • Foyer • Cash Bar

7:00 pm — **Banquet and Awards Presentation**
Salons A–B
Guest Entertainment: SOWING WILD OATS, Merrilyn Belgum, Comedienne

WEDNESDAY, JUNE 22, 1994 • Salons C–D

8:15 am - 11:30 am — **OAT GENOME/GENE POOL**
Moderator, P. Murphy, Department of Crop Science, NC State University, Raleigh, NC

8:30 am - 8:50 am — **Most Recent Version of the Oat Genome Map**
L. O'Donoughue, Agriculture Canada, Ottawa, Ontario and
8:50 am - 9:10 am — Mark Sorrels*, Department of Plant Breeding and Biometry, Cornell University, Ithaca, NY

9:10 am - 9:30 am — **Utilization of the Genome Map in Oat Breeding**
M. Sorrells

9:30 am - 9:45 am — **Recent Techniques in Oat Cytogenetics**
E. Jellen, USDA/ARS and Department of Agronomy, Kansas State University, Manhattan, KS

9:45 am - 10:15 am — **Intercontinental Germplasm Exchange**
J. Valentine, Institute of Grassland and Environmental Research, Aberystwyth, Wales, UK

10:15 am - 10:45 am — **Break** • Foyer

10:45 am - 11:00 am — **Wide Crosses Within Avena**
R. Forsberg, Professor Emeritus, Department of Agronomy, University of WI, Madison, WI

11:00 am - 11:30 am — **Wide Crosses Beyond Avena**
O. Riera-Lizarazu, Department of Agronomy and Plant Genetics, University of MN, St. Paul, MN

11:45 am — Discussion

2:00 pm — **Lunch; American Oat Workers Business Meeting** • Salons A–B

Adjourn/NOIC Meeting

* Presenter

ABSTRACTS FOR POSTERS

AMERICAN OAT

WORKERS

CONFERENCE

June 19-22, 1994

Minneapolis, MN

GENOMIC *IN SITU* HYBRIDIZATION IN *AVENA SATIVA L.*

Qianfa Chen and Ken Armstrong
Plant Research Centre, Agriculture Canada
Building #50, Central Experimental Farm
Ottawa, Ontario, Canada K1A 0C6

Genomic fluorescent *in situ* hybridization was employed in the study of the genome organization and evolution of hexaploid oat (*Avena sativa L.* cv Sun II, AACCDD, 2n = 6x = 42). Genomic DNAs from two diploid oat species *Avena strigosa* (genomic constitution A_sA_s, 2n = 14) and *Avena pilosa* (genomic constitution C_pC_p, 2n = 14) were used as probes in the study. The DNA from *A. strigosa* labelled 28 of the 42 (2/3) chromosomes of the hexaploid oat while 14 of the 42 (1/3) chromosomes were labelled with *A. pilosa* DNA, indicating a close relationship between the A and D genomes. Results also suggested that at least 18 chromosomes (9 pairs) were involved in inter-genomic interchanges between the A and C genomes.

Qianfa Chen (613) 995-3700, Fax (613) 992-7909
E-mail: EM220CYTO@NCCCOT2.AGR.CA

Genetics of Resistance to *Puccinia coronata* in Two *Avena* Accessions from the National Research Council Germplasm Institute, Bari, Italy

J. Chong and P.D. Brown
Agriculture and Agri-Food Canada Research Centre
195 Dafoe Road, Winnipeg, MB, Canada R3T 2M9

The crown rust pathogen (*Puccinia coronata* Cda. f. sp. *avenae* Eriks.) is highly variable in virulence, and can rapidly evolve new virulent pathotypes that overcome commonly used resistance genotypes in oat (*Avena sativa* L.). One of the breeding objectives at the Winnipeg Research Centre is to develop oat cultivars with long term resistance to crown rust by 'pyramiding' highly effective resistance genes. Important to this breeding strategy is to have diverse sources of effective resistance. The objectives of this study were to identify the resistance genotypes in two hexaploid oat (*A. sativa*) accessions and to evaluate their effectiveness.

Forty-five accessions of hexaploid oat, obtained from the National Research Council Germplasm Institute, Bari, Italy, were evaluated for seedling reactions to six greenhouse isolates of crown rust in 1986. Many accessions were susceptible to all six isolates; several accessions showed resistance to four or more isolates but were heterogeneous for rust reactions. Single rust resistant plants were selected from two of the accessions, MG 85039 and MG 85181, for genetic studies; these were crossed to a susceptible cultivar, Makuru. Tests on seedling plants of F_3 families of the cross involving the resistant plant from MG 85039 indicated that the resistance was due to two genes, designated temporarily as *PcA* and *PcB*. Gene *PcA* conferred resistance to 17 of the 20 isolates tested, and is linked to *Pc35*. Gene *PcB* conditioned resistance to three of the 18 isolates tested. Tests of F_3 families of the cross involving the resistant plant from MG 85181 indicated the resistance was due to a single gene, designated *PcC*. This gene conditioned resistance to 10 of the 20 isolates tested. The effectiveness of the above three genes was evaluated against crown rust field isolates obtained from annual rust surveys in Canada in 1991, 1992, and 1993. Gene *PcA* was highly resistant to over 98% of the crown rust isolates in the prairie rust population and to over 86% of the isolates in Ontario in all three years. Gene *PcB* was ineffective in the prairie region and 32% effective in the Ontario population in 1992. Gene *PcC* was effective to over 50% of the isolates in both regions in 1991. Gene *PcA* appears to be a new gene not previously described and is a potentially useful source of resistance to crown rust, particularly in the Canadian prairie region. It is being incorporated in the Winnipeg breeding program into oat lines having the *Pc38, Pc39, Pc48* or *Pc38, Pc39, Pc68* gene combination.

James Chong (204) 983-0932, FAX (204) 983-4604

Comparison of Methodologies for Germplasm Introgression into a Long-term Recurrent Selection Population in Oat

D. J. DOLAN* AND D. STUTHMAN
University of Minnesota
St. Paul, MN 55108

Methodologies for introgression of elite germplasm into a closed recurrent selection population were compared in an effort to correct agronomic deficiencies resulting from single trait selection. Single crosses of C_4 parents to oat varieties Ogle and Starter produced progeny with partial correction of agronomic trait deficiencies while maintaining yield gains. Selected lines from these single crosses were intercrossed to create a doublecross population, crossed to the oat variety Hazel and an Illinois experimental line 83-8037 to generate three-way crosses, and backcrossed to Starter. A restricted index, a Smith index, a modified base index, a multiplicative index, independent culling, and selection for grain yield alone were evaluated for their effect on total genotypic worth and individual trait responses. Traits evaluated were yield, heading date, height, and barley yellow dwarf reaction. The restricted, Smith, and independent culling selection methods surpassed selection for yield alone in the average genotypic worth of their selected genotypes. The three-way crosses contained a significantly higher proportion of lines superior in genotypic worth than the doublecrosses or backcrosses. Expected gains in genotypic worth following two-stage (among and within crosses) restricted index selection was 21.2% for the three-way crosses, 8.6% for the doublecrosses, and 3.4% for the backcrosses. This study found moderate gains in heading date and plant height were possible with only slight reductions in yield; greater improvements in these characteristics were associated with greater losses in yield gain.

D. J. Dolan, (612) 625-9760, FAX (612) 625-1268

DEVELOPING TETRAPLOID OATS

Gideon Ladizinsky
Hebrew University, Faculty of Agriculture, Rehovot 76 100, Israel

Domesticated oats are mainly hexaploids (2n=6x=42). Tetraploid oats (2n=4x=28) are all wild but possess valuable genetic diversity. If domesticated, they may be significant for both oat production and breeding. Attempts have been made to domesticate the tetraploids A. magna and A. murphyi by transferring to them the domesticate syndrome of the common oat. The sterile A. sativa x A. magna and A. sativa x A. murphyi pentaploid hybrids were back-crossed to the tetraploid parent. Among the progeny fertile tetraploids with erect growth, nonshattering panicle, yellow and glabrous lemmas, and absence of reduced awns were selected. These plants were rehybridized with A. sativa and followed by another selection cycle. Morphologically, the domesticated tetraploids are almost indistinguishable from the hexaploid common oat.

Domesticated A. magna was crossed with the diploid A. strigosa, var. Saia, and fertile synthetic hexaploids have been produced following chromosome doubling of the sterile triploid hybrid. This synthetic hexaploid with novel genomic combination seems to have almost immediate commercial value.

Gideon Ladizinsky 972-8-481251, FAX 972-8-468265

Mapping Dwarfing Genes in Oat

Sandra C.K. Milach, Howard W. Rines* and Ronald L. Phillips
Univ. of Minnesota and *USDA-ARS
St. Paul, Minnesota, 55108

Although there have been seven dwarfing genes genetically classified in hexaploid oat, only two are still available in the germplasm: *Dw6* and *Dw7* dominant genes in OT207 and NC2967-3 genetic backgrounds, respectively. A third locus has been recently identified from seven dwarf lines isolated in Japan from accessions of *Avena fatua* L. and introgressed into cultivated hexaploid oat (*A. sativa* L., cv. Kanota) (*Dw8* gene). The objective of this study is to locate these three distinct dominant loci controlling dwarfness in the hexaploid oat RFLP map to identify genomic regions which might contribute to plant height. Polymorphic markers potentially associated with the three dwarfing loci were identified using Bulked Segregant Analysis. F_2 linkage data has confirmed that: a) the *Dw6* dwarfing gene, present in OT207 line, is located 3.5 map units from the marker UMN145B; b) the *Dw7* dwarfing gene, present in NC2469-3 line, is about 5 map units from the marker CDO1437B; c) the *Dw8* gene, probably in all of the Japanese lines, is about 6 map units from the marker CDO1319B. These linkage associations locate the *Dw6* gene on the smallest oat chromosome (chromosome 18), *Dw7* gene on the longest satellited chromosome and the *Dw8* gene on the submedian 13 (5C) chromosome, based on the previous assignment of the RFLP markers to those physical chromosomes.

Sandra C.K. Milach (612) 625-6223, FAX (612) 625-1268

TRANSGENE INTEGRATION, EXPRESSION AND INHERITANCE IN OAT

W. P. Pawlowski, K. A. Torbert, *H. W. Rines and D. A. Somers
University of Minnesota and *USDA-ARS, St. Paul, MN 55108

Friable, embryogenic oat tissue cultures were bombarded to deliver the plasmid pBARGUS containing the *Escherichia coli* β-glucuronidase gene (*uidA*) and the *Streptomyces hygroscopicus* phosphinothricin acetyltransferase gene (*bar*). Transgene integration was detected, using Southern blot analysis, in 98% of tissue cultures selected on PPT. Inheritance of transgene phenotype was analyzed in transgenic plants in R_1 and, in some cases, also R_2 generations. Detection of transgene phenotype was based on assaying GUS activity in kernel endosperm. Fourteen families exhibited ratios of transgene inheritance close to 3:1, suggesting the presence of one functional transgene locus. Four families showed segregation ratios implying that two independent transgene loci were present in the plant genome. Deviations from expected Mendelian ratios of inheritance were found in eight families. Apparent lack of PAT and GUS coexpression was observed in two of seven families in which plants were also screened for PPT resistance. These events may be caused by cosuppression, a phenomenon of gene inactivation associated with presence of multiple copies of a gene.

Wojtek P. Pawlowski (612) 625-8107

Oat Tocols: Effects of Processing, Stability, and Relation to Oil Content

David M. Peterson
Cereal Crops Research Unit, USDA-ARS,
and University of Wisconsin, Madison, WI 53705.

Cereals, including oat, are good sources of tocols (vitamin E), an important antioxidant with cholesterol-lowering properties. Experiments were designed to determine the effects of processing on the specific tocol content of oat and the stability of tocols in the stored products. Also, oat lines of various oil concentrations were analyzed to determine whether there was a relationship between tocol and oil content. Oat products including dried and undried groats, flakes, flour and bran were stored 7 months in jars or envelopes at room temperature and in a freezer. In all freshly prepared products, α–tocotrienol was the predominant tocol, followed by α–tocopherol. β–Tocotrienol was increased by processing. Tocols degraded in all products stored at room temperature except undried groats, but they were stable in the freezer in all products. Tocols degraded faster at room temperature in envelopes than in jars, indicating that the presence of air may be involved in the degradation process. As a percentage of total tocols, α–tocopherol, α–tocotrienol, and δ–tocotrienol decreased and β–tocopherol, β–tocotrienol, and γ–tocopherol increased. In a series of high-oil lines produced by recurrent selection at Iowa State University, there was a strong positive correlation between tocotrienol concentration and oil concentration, but tocopherol concentration was not correlated with oil concentration. Tocotrienols are located primarily in the endosperm, whereas tocopherols are mostly located in the germ. It was concluded that drying the groats probably initiates tocol degradation, and for maximum benefit, products should be consumed while fresh or stored in a freezer. High tocol content may be an added benefit of breeding for high oil.

David M. Peterson (608)262-4482, FAX (608)264-5528

EFFECTS OF HARMONY EXTRA ON OAT CULTIVARS

D. L. Reeves, J. C. Golden, L. Hall, and L. Wrage
South Dakota State University
Brookings, SD 57007

Sixteen oat Avena sativa L. cultivars were tested for sensitivity to Harmony Extra (Trifensulfuron + Tribenuron) in a replicated field test. Rates used were 0, 1/2 and 1 oz/A which represents recommended and 2 x rates. Highly significant effects were present for yield, heading date, height and lodging. There was a strong cultivar x herbicide interaction, especially for grain yield. Ogle, Porter and Premier were the most sensitive having reductions in yield up to 90% and height 70%. Other cultivars such as Hazel and Settler had no reductions in yield and only small height changes. Test weight appeared to be lowered by 1.5 lb/bu at both rates. Lodging appeared to increase with increasing rates. Due to the drastic effects of Harmony Extra on certain cultivars, breeders and oat producers need to be very cautious about using it on oats.

D.L. Reeves 606/688-4756, FAX 605/688-4452

Improved groat protein concentration in western Canadian oat cultivars.

B.G.Rossnagel* and R.S.Bhatty
Crop Development Centre, University of Saskatchewan
Saskatoon, S7N 0W0

The % groat protein of western Canadian oat needs improvement of 1 - 2% to aid in further penetration of the US milling oat market. Genetic improvement is feasible and the Crop Development Centre oat R&D project has evaluated several germplasm sources as increased protein donors, including, Avena magna and A. sterilis derived A. sativa, and foreign A. sativa introductions. 1991 - 1993 results indicate that the A. magna derivatives are of little value, A. sterilis derivatives offer the best potential for protein increases of greater than 2%, and A. sativa introductions from Wales, Norway, and the USA offer best short term potential to increase protein by the 1 - 2% goal originally set. Deficiencies in physical grain quality of these lines have been overcome by rigorous selection with best lines having quality comparable to local checks, slightly lower yields and 1 - 3.5% improved groat protein concentration.

Brian Rossnagel (306)966-4976, FAX (306)966-5015,
Email rossnagel@sask.usask.ca

Advanced Mexican Oat Germplasm Resistant to Stem Rust (Puccinia graminis f. sp. avenae) and Crown Rust (Puccinia coronata f. sp. avenae)

Jose J. Salmeron, Don E. Harder, and James Chong
INIFAP-Mexico and Agriculture and Agri-Food Research Centre Winnipeg, Mb. 195
Cd. Cuauhtemoc, Chih., 31500, Mexico

Advanced oat mexican germplasm in F_5 and F_6 generations and some introductions from USA and Australia were tested for resistance to stem and crown rust. This material was evaluated individually in seedling stage at Winnipeg, Canada with stem rust races: NA8,16,25,26,27,28,55 and crown rust accesions CR13,20,36,50,152,169,185,225. The same material was tested at the adult stage in field nurseries that were inoculated with the composite of the above isolates for stem rust and with races CR13 and CR36 for crown rust.
Of the 142 genotypes evaluated in seedling stage to stem rust, 76 were resistance to all races but NA28, indicating the presence of gene combinations or gene Pga. Also the presence of Pg2 was found as an independent and in combination with Pg9 and Pg13. The adult plant resistance indicated the presence of gene Pg11. For crown rust 38, lines were resistant in the field and seedling test suggesting the concurence of several combined genes or possibly genes Pc 58, Pc59, and Pc 60. The results confirm previous studies to detect resistance with progenitors used in the breeding program in Mexico.

Jose J. Salmeron (52-158) 22258, FAX (52-158) 23110

Inheritance of Stem and Crown Rust Resistance in Three Mexican Oat Lines

Jose J. Salmeron, Don E. Harder and James Chong
INIFAP-Mexico and Agriculture and Agri-Food Research Centre, Winnipeg, MB,
Cd. Cuauhtemoc, Chih., 31500, Mexico

Three Mexican oat lines: Huamantla "s" (S-132), Tul/Romulo (CB48) and 11630/Nuprime/Dia"s"/Hajira/Joanette/LMHJA/CI8091 (CB52) were studied in seedling stage using Rodney O as a susceptible cultivar. The F2 segregations from crosses between the three lines and Rodney O when tested with NA 27 gave good fit to a 1 resistant : 3 susceptibles ratio (P=.50-.70), it was concluded that a single recessive gene confers seedling resistance in the three lines. F2 populations from crosses of the three lines and Pga monogenic line using stem rust race NA 27 did not show segregation. It was concluded that the three lines carrying similar gene as Pga line.

When tested with the crown rust race CR 152 the F2 populations of Rodney O x S-132 and Rodney O x CB48 gave a good fit to a 15 resistant : 1 susceptible ratio (P=.20-.30 and P=.50-.70 respectively) indicating that two genes are involved in the resistance to the crown rust isolate CR 152. With race CR 169 the same two above crosses gave good fit to a 3 resistant : 1 susceptible ratio (P=.20-.30) proving that a gene confers resistance to CR 169. Further studies are needed to determine the gene responsible for crown rust resistance.

Jose J. Salmeron (52-158) 22258 FAX (52-158) 23110

Paromomycin: An Improved Selective Agent in Oat Transformation Technology

K. A. Torbert, S. C. K. Milach, H. W. Rines*, and D. A. Somers
University of Minnesota and *USDA-ARS
St. Paul, MN 55108

An improved selection system in oat has been established. The antibiotic paromomycin sulfate has shown to be successful in selecting transformed friable, embryogenic 'GAF/PARK' callus in microprojectile bombardment experiments. Plasmids containing genes encoding ß-glucuronidase (GUS) and *E. coli* tn5 neomycin phosphotransferase II gene (NPT II) were delivered into callus tissue. The *npt* II gene confers resistance to paromomycin. Two independent experiments yielded 89 paromomycin-resistant tissue cultures isolated from 28 bombarded treatments. Eighty-eight paromomycin-resistant tissue cultures were confirmed to be transgenic based on Southern blot analysis and detection of the NPT II protein using the ELISA assay. Twenty-nine positive NPT II isolates were shown to have the *npt* II probe hybridizing only to their high molecular weight DNA by Southern analysis. These results demonstrate the effectiveness of the *npt* II/paromomycin combination to successfully isolate paromomycin-resistant tissue cultures. Paromomycin-resistant tissue cultures showed expression of the ß-glucuronidase gene in 39 of 50 colonies. Thirty-two of the 88 transgenic tissue cultures regenerated plants. Thirty of these plants exhibited NPT II expression in leaf tissue. Regenerated plants were fertile in 17 of the 32 culture lines. Inheritance of the *npt* II gene showing stable integration was detected in 16 of the 17 fertile culture lines. Also, GUS activity in seeds was expressed in 10 of 12 pNGI transgenic culture lines with fertile regenerants. This selection system was used in elite oat lines, 'Starter' and 'Donald', and nine paromomycin-resistant colonies were selected that integrated the *npt* II gene and expressed the NPT II protein. Plants were regenerated from these transgenic cultures, but were not fertile.

Kimberly A. Torbert (612) 625-8107, FAX (612) 625-1268

Resistance to Oat Mosaic Virus and Oat Golden Stripe Virus in Winter Oats

S. L. Walker, S. Leath*, J. P. Murphy, S. A. Lommel
North Carolina State University, and *USDA-ARS
Raleigh, NC 27695-7616

Coker 716, a hexaploid winter oat cultivar resistant to oat mosaic virus (OMV) and oat golden stripe virus (OGSV) was crossed to three susceptible oat cultivars: Brooks, Madison, and Tech. A total of 190 $F_{2:3}$ derived lines were developed from the three crosses and were evaluated for disease resistance and yield response in field plots located in two environments. Experiments also will be repeated in the 1994-95 season. A screen of 90 randomly amplified polymorphic DNA (RAPD) primers on each of the four parental cultivars revealed that 31 primers generate 194 polymorphisms which occur only in the resistant Coker parent. Disease intensity for each line is being compared to RAPD results. The segregation of the 194 polymorphisms in the $F_{2:3}$ lines and level of disease resistance in the field for each line should establish specific markers for resistance to OMV and OGSV which could be used for early generation screening of oat breeding lines.

Steven Leath (919) 515-6819, FAX (919) 515-7716

Evaluation of Oat Germplasm for Agronomic and Quality Characters

Darrell M. Wesenberg*, David M. Peterson, and Dave E. Burrup
ARS-USDA
National Small Grains Germplasm Research Facility, Aberdeen, ID 83210
Cereal Crops Research Unit, Madison, WI 53705

Oat (Avena sativa L.) varieties and selections from the Uniform Midseason Oat Nursery, Uniform Early Oat Nursery, Uniform Northwestern States Oat Nursery, and other oat trials, grown at Aberdeen, ID under irrigation, and at Tetonia, ID under irrigation and dryland (non-irrigated) conditions were evaluated for several agronomic and quality traits. Data were obtained for yield, test weight, heading date, height, lodging, kernel weight, and groat content at the two locations. Groat samples were sent to Madison, WI for analysis of protein and beta-glucan concentration. Effects of genotype, environment, and in their interaction were calculated. The results obtained during 1989-92 are summarized in a report available to interested oat workers.

Darrell M. Wesenberg (208) 397-4162, FAX (208) 397-4165

Mapping of the Centromere in Telocentric IX of Sun II Oat Reveals Higher Recombination in Male Versus Female Gametes

Bai-chai Wu, Shahryar F. Kianian, Ronald L. Phillips, Howard W. Rines*, University of Minnesota and *USDA-ARS, St. Paul, MN 55108

Ditelosomic line DIX of 'Sun II' oat (*Avena sativa* L., 2n=6x=42) was crossed with euploid 'Kanota' to derive populations for mapping RFLP markers in relation to the centromere. Chromosomal constitutions of F_2 plants and of plants from reciprocal crosses between the heteromorphic F_1 and the Kanota parent were obtained by cytological observation and confirmed by RFLP analysis of a rDNA sequence located on the missing arm of DIX. Transmission frequencies of male and female telosomic gametes were 0.21 and 0.27, respectively. Recombination values were obtained by analyzing the chromosome constitution and RFLP patterns for 11 markers in the progeny populations. Eleven RFLP markers had previously been located on the long arm of chromosome IX by nullisomic / ditelosomic analysis. RFLP marker UMN333 was linked to the centromere with a recombination value of 25.5%. The total distance covered by the 11 markers appears to be at least 200 map units. In this study, we observed that the recombination frequency was about 50% higher when the heteromorphic F_1 was used as male versus female in the cross with Kanota. Total map units among seven loci in a linkage group on DIX as determined in F_2, backcross as male, and backcross as female populations were 91.9 map units, 153 map units, and 87.7 map units, respectively. Other linkage groups showed similar trends. For example, the total map units among markers in linkage group 18 for F_2, backcross as male and backcross as female populations were 99.7, 151.3 and 87.9, respectively, and for linkage group 20 the values were 134.6, 150.0 and 90.9, respectively. Linkage values between specific markers not included in these linkage groups also demonstrate this trend toward higher recombination in male versus female populations.

Ronald L. Phillips (612) 625-1213, FAX (612) 625-1268

PRESENTATION ABSTRACTS

AMERICAN OAT WORKERS

CONFERENCE

JUNE 19-22, 1994

MINNEAPOLIS, MN

Defining Quality

A. Bruce Roskens
Senior Manager - Commodity Development
The Quaker Oats Company
321 N. Clark Street, Chicago, IL 60610-9001

There are as many definitions of quality as there are producers, merchants, and end-users. Even Webster's dictionary has multiple definitions, including noun, verb, and adjective forms. It can therefore be determined that quality is not a defined target, but rather a continuing process an ever-evolving goal. Clearly the grain industry has multiple definitions, from USDA-FGIS standards, to end-users specific needs.

While it is doubtful that all end-users will agree on the terms and/or the process of quality, it is clear that viewing oats and other grain simply under the terms of commodity grades is not adequate. As end-users streamline, cost reduce, and pursue supply chain initiatives, and implement Total Quality Management, they need to view grain as an ingredient versus a commodity, and source their grain based upon intrinsic physical and chemical characteristics.

The oat industry is poised for this approach. As oat researchers worldwide better understand and begin to control and manipulate quality factors including density, shape, size, fat, protein, and beta glucan, the end-user must communicate the factors that drive value for them. With the reduction of oat acreage and use as feed worldwide, we actually should be able to better control the type of oats produced. This must be communicated clearly, however, throughout the supply chain.

Another term usually associated with Continuous Quality Improvement and TQM is Partnership. Without a doubt, end-users, researchers, producers, and merchants must partner together if quality improvement is going to occur and all parties reap the benefits. I believe the future of the oat industry depends on the enhanced communications of quality needs throughout the supply chain, and that the concept of quality will continue to evolve with ever increasing levels of quality as multiple goals.

A. Bruce Roskens (312) 222-6952, FAX (312) 222-6662

Breeding Quality Oat

B.G.Rossnagel*
Crop Development Centre, University of Saskatchewan
Saskatoon, Canada

Breeding quality oat requires knowledge of the customer's needs and the genetic and environmental limitations facing the breeder. Focused, hierarchial elimination of poorer genotypes through successive generations at increasing numbers of testing locations results in the identification of best quality genotypes. In the CDC program physical grain quality testing begins at the F4 generation, keeping in mind both the heritability of various traits and the ease of selection for them, and is carried out and increased through at least the F11 generation. Building on the base established by the variety Calibre (1983), the program has released Derby (1988) and CDC Boyer (1994), each with improved quality and performance. Parental selection is the most critical step followed by rigorous visual and measured selection always noting that the elimination of the poorest lines in each successive generation will eventually lead to a small but very good set of lines from which to select within and eventually between cross combinations. Critical selection criteria include % hull, grain size, shape and uniformity, test weight, colour and groat protein concentration. The Canadian system of Cooperative testing and peer evaluation aids greatly in our success.

Brian Rossnagel (306)966-4976, FAX (306)966-5015
Email rossnagel@sask.usask.ca

OAT PRODUCTION AND HANDLING IN CANADA

William Hill - Manager, Western Feedgrains Division
United Grain Growers
Calgary, Alberta
Canada

Oat acreage and production in the United States has been falling steadily for the past five years. Canada, Finland and Sweden have made up this shortfall. Canada has been the largest supplier of the three and Canadian oats exports to the US have been rising yearly. With the exit of the Canadian Wheat Board in 1988 from the market, oats has become an important deregulated cash crop for Canadian farmers. This trend of increaed Canadian oat exports can be expected to continue. US farmers have many economically viable alternatives to growing oats, whereas Canadian farmers do not. Oats are ideally suited to Canada's climate, especially now that new varieties have been developed for southern regions of Manitoba and Saskatchewan. Reduced subsidies in the Scandinavian countries due to their entry into the EEC and under the new GATT agreement will result in a corresponding reduction in production and exports. Canada will not feel the same impact on oats production from reduced transportation subsidies under GATT because the subsidy will be consistant for all grains and because much of the current US export business is transacted without a freight subsidy. Trade flows may change as Thunderbay becomes less viable and direct rail becomes the alternative of choice. Increased direct rail business will put stress on the rail system and force quality control from Thunderbay into the country. Many companies in Canada, UGG included have installed country cleaning and have had success in shipping direct from the country without cleaning both by truck and rail. Even without a freight subsidy vessel business from Thunderbay will continue to certain destinations. Changes to the transportation subsidy may also shift acreage from Alberta to Manitoba as the acreage moves closer to the market. Our close proximity to the US milling industry has seen our export focus shift from feed to human consupmtion. The biggest challenge for the oats industry in Canada is to develop varieties with consistant and higher protein levels for the milling industry. In past years frost damage and low proteins have made Canadian oats less competitive to both US and Scandinavian production. Lower protein is not as important a factor in the feed market but distance has made it difficult to compete in the south against cheaper Scandinavian product. As a result much of the export feed trade is high quality cleaned and sized product. Canadian farmers are able to grow a high quality product at a competitive price, as long as there is a market in the US, the Canadian farmer will continue to capitalize on this competitive advantage.

William Hill (403)250-7200 FAX (403)291-9118

20 June 1994

Prepared for the 1994 American Oats Workers Conference
By Mike Willette Delavan, Mn 56023

See Minnesota Extension Service bulletin AG-FO-2900, 1986 for many details in producing a PROFITABLE crop of oats.

Some considerations on producing a QUALITY crop of oats.

1. Early planting. Consider primary field preparation in the fall.

2. Fertilize according to soil test. We spread a low level of about 200 lbs of 6-24-12. The balanced fertilizer should develop good straw strength. Oats that lodge will normally lose test weight.

3. Oats likes a firm seed bed with good seed-to-soil contact. If a press drill is not used then fields that are not subject to wind erosion could be rolled with a cultipacker. Other fields should be harrowed.

4. Variety selection is the most important consideration. Use test data collected as close to your area as possible. Select more than one maturity and consider test weight, protein, disease reaction, and groat percentage. Avoid varieties that are not resistant to seed born diseases such as smut. Last year's smut is this year's problem.

5. A planting rate of about 15 seeds per linear foot of row in 6 inch rows is recommended. If the planting is delayed consider increasing the rate by 20%.

6 Weed control is a necessary part of producing quality grain.

7. We want the oats crop ripe when it is windrowed. There will be a loss of test weight if the oats is harvested or even windrowed on the green side.

8. A properly set combine will reduce breakage, dehulling and will discharge the chaff with the straw. Some varieties with hull ends and hairs need a fine tuned combine setting as an attempt to smooth the seed . and increase the test weight

9. We like a kernel moisture of about 12%. It is difficult to adjust the combine if the grain or straw is wet. It is important to level the grain in storage. Also remove any heat from the grain with aeration as soon as possible

10. Quality is related to price. The cash price for oats effects the additude of the operator. The farmer may raise a small field of oats but he will ignoore the field and spend his efforts and quality considerations on a profitable crop.

11. The most important items that produce quality.
    a. Variety selection
    b Early planting with fertilization
    c. Harvest when mature

Mind Your "P"s and Improve "Q"

William Bonner, Alan Koechner, and Jeffrey Levine
ConAgra Specialty Grain Products Company
Omaha,NE 68102

Processing quality can be defined simply as attaining what the end user wants. Too often in each of our individual efforts we envision that end user to be the next specific link in the process chain. The seed grower relates to the farmer, the scientist to fulfilling his contract research, the buyer to executing an effective trade, the processor to quality flakes and flour for on time delivery to be further processed or packaged into cookies, hot and ready to eat cereals or cosmetics. In fact process quality starts from basic research and doesn't stop until someone is happily munching on a granola bar. There are many "P"s that require attention in giving us an overview to process quality improvements. There is more to this alphabet soup than the "P"s: Protein, Product, Pests, People, Package, Printing, Progress, Pride, Productivity, and Perception.

William A. Bonner (402) 595-4585, FAX(402) 595-4233

NOVEL INDUSTRIAL USES FOR OATS

JOHN SCHAW
CANAMINO INC.
SASKATOON, SASKATCHEWAN, CANADA

50 MILLION SCOTSMEN CAN'T BE WRONG OR SHOULD IT READ 50 MILLION RACE HORSES CAN'T BE WRONG. OATS ARE GREAT! OATS ARE MAGIC! OATS ARE POTENTIALLY THE BEST CEREAL CROP IN THE WORLD. WE ALL KNOW THAT OAT MEAL PORRIDGE FOR BREAKFAST IS THE BEST WAY TO START THE DAY. WE ALL KNOW THAT OAT BRAN MUFFINS ARE FAR SUPERIOR TO ANY OTHER BRAN MUFFINS. WE LIKELY ALL KNOW THAT OAT BETA GLUCAN IS THE ACTIVE INGREDIENT THAT REDUCES ONES CHANCE OF HAVING A HEART ATTACK. BUT DO WE KNOW, FOR EXAMPLE, THAT A COLLOIDAL OAT MEAL BATH WILL REDUCE THE ITCH OF POISON IVY AND POISON OAK? THE FDA KNOWS! THE FDA HAS ISSUED A TENTATIVE FINAL MONOGRAPH THAT SAYS SO. WE SELL FRACTIONS OF THE OAT AS INGREDIENTS FOR COSMETIC AND SKIN CARE FORMULATIONS; SURFACE TREATED OAT STARCH AS A REPLACEMENT FOR TALC, HYDROLYZED OAT PROTEIN AS A BASE FOR SHAMPOOS AND LOTIONS, OAT BETA GLUCAN AS A SUPER MOISTURIZER FOR THE SKIN, AN OAT EXTRACT TO REDUCE SKIN IRRITATION AND MANY OTHERS. IN ADDITION TO COSMETICS AND FOOD, APPLICATIONS FOR OAT FRACTIONS ARE SPRINGING UP IN PET CARE PRODUCTS, VETERINARY MEDICINE, AND HUMAN PHARMACEUTICALS. RESEARCH HAS ONLY SCRATCHED THE SURFACE WHEN IT COMES TO POTENTIAL APPLICATIONS OF THE OAT AND ITS FRACTIONS. AS SHAKESPEARE MIGHT HAVE SAID, WE SHOULD BE HERE TO PRAISE THE OAT NOT TO BURY IT.

JOHN SCHAW (306) 975-2030, FAX (306) 975-2049

Why Genetically Engineer Oats?

Ronald L. Phillips
Regents' Professor, University of Minnesota, St. Paul

The answer to the question "Why genetically engineer oats?" that comes to mind after listening to Wilford Brimley on the Quaker Oats TV ads is: "Because it's the right thing to do". But the public and other scientists ask: "Is it safe?"; "Can it be done any other way?"; "Is it cheaper and/or quicker?"; or "Does it make moral, social, or economic sense?" It is a good question to address at this meeting because the genetic engineering of oats is now a reality.

I have personally struggled with this question because of all the negative perceptions associated with genetic engineering. The goals of genetic engineering are the same as for standard plant breeding. Because plant breeding is an ever-evolving science and genetics is the underlying basis of the theory and practice of plant breeding, the utilization of all genetic tools available should only improve the methodology. The most recent genetic tool available to those interested in plant improvement is genetic engineering - or gene transfer by molecular means.

My first inclination is to turn the question around, and ask: Why not genetically engineer oats? But I will resist the temptation, for now, and stick to my assigned question.

The methodology of plant breeding is comprised of several steps. The first of these steps is the selection of parents. It is often said that genetic engineering technology makes available biological materials never accessible before for improving a particular crop. This aspect is so obvious that it may have been grossly overplayed, such that we tend not to consider the benefits of using genetic engineering to incorporate traits from the same or a cross-compatible species.

The second step is hybridization, which is a prerequisite in standard plant breeding for combining traits of interest. I often think that "The worst thing a plant breeder can do is to make a cross!" To incorporate a new trait, the plant breeder makes a cross and thereby brings together the genes - in a 50:50 ratio - of the highly acceptable parent with those of the less acceptable parent. This problem is overcome, in part, by plant breeders only crossing "good X good" to generate the next variety. In most highly fine-tuned plant breeding programs, limited use is made of exotic lines or related species.

The plant breeder is faced with a probability dilemma when making crosses. Suppose a cross is made between an adapted oat line and an unadapted one carrying a useful trait controlled by a single gene. What is the probability in the hybrid of obtaining a 21-chromosome gamete with 20 chromosomes from the adapted line and the one chromosome of interest from the unadapted line? It is about 1 in a million! And that assumes no recombination.

Being able to introduce individual genes of interest might encourage the greater use of the germplasm collections held around the world. Cultivated oat has several related taxa at the hexaploid, tetraploid, and diploid levels. Traits from some of these species have played an important role in oat improvement, especially disease resistance from *Avena sterilis*. As oats is improved to a greater and greater extent, will related species be used as much as they are today?

The third step in plant breeding involves the advancement of generations to allow recombination of genetic material, coupled with selection of at least the highly heritable traits. However, it is very difficult to achieve the ideal result. Linkage drag, or the maintenance through generations of large chromosome segments, can be a problem. The relative difficulty of making backcrosses in oat, and the ease of self-pollination, probably leads to significant amounts of linkage drag. This would be minimized by genetic engineering approaches.

Negative correlations of important traits is often a problem in plant breeding. Yield and protein and yield and maturity are often negatively correlated. The underlying basis of these negative correlations may be either physiological interactions or genetic linkage. Genetic engineering might reduce the occurrences of negative correlations if the cause is linkage.

The fourth step in a plant breeding program is evaluation, which can occupy up to half of the 8 to 12 year timeframe for standard plant breeding to generate a new variety. Even the introduction of single genes by plant breeding methods are not sufficiently foolproof to eliminate the need for extensive testing. In fact, some corn companies do not like to backcross in single genes because of the linkage drag and the necessary testing. They are trying to overcome the problem by the use of Restriction Fragment Length Polymorphisms (RFLPs). As the genetic engineering methods are improved, such as eliminating the need for tissue culture, the day might come when the evaluation phase could become quite short. This could be an important development making genetic engineering especially attractive, at least for relatively simple traits.

Are there other aspects of oat that could make genetic engineering particularly useful? The hexaploid nature of oats imposes certain limitations for the improvement of oats. For example, the *waxy* mutant available in many cereal grains causes a shift in starch composition from a mixture of straight-chained amylose and branch-chained amylopectin to 100% amylopectin. Such a starch composition is useful for many purposes and the *waxy* mutant eliminates the need for separation of the starch types. If *waxy* oat were determined to be of value, the recessive nature of this trait in many other species would imply that homozygosity would be needed at all three putative loci (one in each of the three genomes) for expression. This might be difficult to achieve. However, antisense technology can be used to knock out the expression of genes and results in the dominant expression of the trait. This approach might have numerous uses for oat. The many seed quality traits in other species could be rather easily introduced into oat through this technology.

Another recent advancement in our understanding of cereals comes from comparative mapping studies. At the DNA level, grass species have large blocks of DNA in common.

By comparing the molecular markers linked to a trait of interest in one species with those linked to the same trait in another species, almost identical genes can be pinpointed which control the same trait in the two species. This leads to the conclusion that highly homologous genes, already isolated in another species, can be exploited for the improvement of oat. With genetic engineering, this knowledge might encourage us to use wheat, barley, or rye genes in oat improvement.

Let me speculate even further. Have you ever wondered whether yield in oats is correlated with the degree of heterozygosity among the three genomes? "Built-in heterosis", if you will. If this is the case, molecular techniques might enable the recognition of heterozygosity or perhaps the site-specific mutagenesis of homologous loci. I offer this to broaden our minds to accept the possibility that molecular techniques, probably involving genetic engineering, could revolutionize our plant breeding methods. More likely, however, genetic engineering will be more of an evolutionary force rather than a revolutionary one.

We all clearly understand at this point in history that genetic engineering will enhance our understanding of the basic molecular biology of oat. Current work on barley yellow dwarf virus, chitinases, glucanases, and various promoter constructs all will provide valuable biological information and has the potential of generating valuable lines. Research on movement proteins, for example, that restrict the movement of virus components through the plasmadesmata could lead to a more general and durable form of disease resistance. The cosuppression phenomenon, where the introduction of a gene causes the suppression of itself and the endogenous homologous gene, is another interesting biological phenomenon - discovered through genetic engineering technology - that has basic and practical implications. And, of course, the introduction of transposable elements into oat from heterologous systems offers great potential for cloning genes.

Does genetic engineering offer anything that might stem the trend toward lower oat production? The tremendous array of options that genetic engineering allows should result in the ability to produce a greater spectrum of value added or identity-preserved types of oat. The availability of oat for specialized purposes may be a useful strategy to offset the decline of oat as livestock feed. Continuing to capitalize on oat as a healthful food would appear to be appropriate. This is in keeping with the title of this conference "Oats for the 21st Century: DNA to the Dinnerplate."

Let's return to the Wilford Brimley quote: "Because it's the right thing to do." There are risks associated with new products from genetic engineering, as there are with standard plant breeding. Perhaps a more common risk of most concern to me is that related to allergies. Because the oat and other cereals of the future might carry genes from here-to-fore cross-incompatible species, new combinations of gene products may be present in the grain. The allergenicity of the new genetic materials must be considered. If a known allergen is involved, the research should not be undertaken.

Although other risks are possible, such as creating weediness, I suspect they will be identified and dealt with just as unanticipated results might be from standard plant breeding. The possibility of chance hybridizing with wild oats is always a factor to monitor.

Another issue is genetic uniformity resulting from the widespread use of a certain genetic type, but again we hopefully have learned from cases of genetic vulnerability created through standard plant breeding.

Another issue has to do with intellectual property rights. The numerous patents applying to genetic engineering protocols and materials is going to complicate the process. However, many materials from standard plant breeding also are being protected today in one form or another.

Finally, we must recognize that the technology related to genetic engineering is developing at an extremely rapid rate - much faster than the rate of development of standard plant breeding methods. This is partly due to the amount of research funding in the human genome project, the plant genome projects of the U.S. (including *Arabidopsis*), the rice genome project of Japan, and many others. And in the area of genetic engineering, advances in almost any organism are also advancements for plants. Our ability to take advantage of these developments for expanding plant breeding technologies will require better funded, integrated plant improvement programs with genetic engineering support services more available to the plant breeder.

In summary, the incorporation of genetic engineering technology in oat improvement programs will likely become commonplace but will depend on the allocation of resources, further technological advances, availability of trained personnel, and public acceptance of the products of genetic engineering.

Food Processing Issues

Myrland Dahl
Malt-O-Meal Company
Northfield, MN 55057

When working with oats, as well as any other cereal ingredient, the issues of interest from the food processors perspective encompass handling (processing) to nutrition. And, recognizing the increasing interest in nutritional issues by consumers, it is requisite for food processors to be aware of the direction of nutrition and of consumer expectation. But, with oats the challenge of "meeting the consumer needs and wants" is confounded by the lack of information regarding the composition and regulation of many of the components of oats as compared with such other cereals as wheat, barley or corn. In wheat and barley the need to develop specific varieties and classes of each of these cereals was pulled through by specific processing needs (the baking and brewing industries, respectively.) On a relative scale, oats is where these cereals were thirty or forty years ago. We need to begin to identify specific changes that would "improve" the suitability of oats to meet human nutritional needs and direct attention to these changes. If we wait for the supplier side to drive the process rather than allow the consumer side to pull the process, a real option is the replacement of oats by other cereals and ingredients that can and will be designed to meet the needs. It is likely that the same oat will not meet all of the needs for oats as a cereal crop. We need to understand such basic issues as what influences water uptake during various processing steps in food production, what determines the "oaty" flavor and how can it be enhanced, what factors influence color development in the finished product, and what is the relationship between fatty levels and fatty acid profiles on processing parameters and finished product nutritional quality and acceptability? Both the understanding of these issues together with the means to tailor the oat are needed. Survival of the industry will be dependent on the willingness of all participants to invest in the future, to recognize the needs and to actively become involved and support the necessary development to make oats not only competitve but to exploit its full potential.

Genetic Engineering -- Opportunities for Processors

Francis H. Webster
The Quaker Oats Company
617 W. Main St.
Barrington, Il 60010

The next decade promises to be the dawn of a new era in agriculture. As we move toward the next century we can anticipate a major shift in the focus of the food and agriculture industry. Historically, the major emphasis of plant breeders has been to increase the yield of food and forage. The rapid development of biotechnology coupled with increased consumer awareness regarding the relationship between diet and health will lead to a shift in the direction of agricultural research. Crop composition will receive much more attention than in the past. The new technologies will make it possible to develop new varieties faster while minimizing the effects of tradition crop development problems such as linkage drag. Application of genetic modification technology will allow the rapid introduction of new traits or regulatory elements for existing traits into elite germplasm. This technology may be especially beneficial for polyploid plants such as oats. As social issues are resolved the technology will receive increasingly more use.

Oat workers are faced with many opportunities and challenges. First, despite excellent productivity by the oat research community, oat acreage continues to decline. Application of the new technologies to competitive crops will threaten to accelerate this decline. The first challenge is to maintain the competitiveness of the oat researchers technology base. The next challenge is to effectively apply this technology to oat improvement. The basic objectives for oat improvement research will remain unchanged. Development of high yielding oat lines, which will provide stable yields when confronted with a wide range of environmental stresses, should be the first order of business. The second step would be to evaluate opportunities to enhance grain quality traits. Consideration should be given to tailoring grain quality characteristics to the specific end market; food or feed. Modifications can be very user specific. The technology opens the door to an almost limitless array of changes. Value will be found in the eye of the visionary.

Genetic Engineering: Production and Ecological Concerns

Ruth G. Shaw
University of Minnesota
St. Paul MN 55108

Genetic engineering holds great promise for enhancing our basic understanding of the genetic basis of form and function. In the context of agriculture for production, however, the ecological risks of genetically engineered crops may be substantial. Early considerations of these risks were based largely on two key generalizations: (1) that the bulk of pollen falls near the source plant and (2) that genetic changes likely to be introduced by genetic engineering put a metabolic burden on the organism. Both of these points initially suggested that plants bearing these changes would not survive or spread in the absence of cultivation. These and other assumptions are receiving increasing attention from ecologists and evolutionary biologists. Although assumption (1) appears to hold in most empirical studies, recent work on radishes by N.C. Ellstrand and colleagues nevertheless demonstrates that appreciable quantities of pollen disperse to at least 1 km and that the fitness of the hybrid progeny can exceed that of the wild parents. Assumption (2) has been supported, for example, by J.S. Holt's studies of herbicide resistance in *Senecio vulgaris*. Nevertheless, given continuing herbicide application, resistance is expected to spread in associated weedy populations. By analogy, weeds may also acquire from crops resistance to insect pests. Moreover, work of R.E. Lenski has shown that organisms may evolve to reduce or eliminate apparent "costs" of resistance, and N. Jordan has demonstrated that such costs are not evident in some herbicide resistant populations of *Amaranthus retroflexus*. Thus, although there is support for the two premises above, it is likely that the inference based on them will often be violated. Escape of engineered genes into natural populations and their persistence may often be very likely. Quantitative assessment of the ecological and evolutionary risks from genetic engineering in agriculture is just beginning. The necessary research into this facet of genetic engineering demands as much innovation, care, dedication, and support, as the molecular aspects. It would be appropriate to require quantitative assessment of ecological risks in the small field trials currently underway as a basis for planning assessment in production fields. Initiatives to study evolutionary responses to genetically engineered crops should also be expanded.

Ruth G. Shaw (612) 624-7206, FAX (612) 624-6777

Who Benefits from Genetic Engineering?

Lawrence Busch
Department of Sociology, Michigan State University
East Lansing, MI 48824

As a result of their potential (1) to compress time and space, and (2) to permit movement of genetic materials across species lines, the new genetic engineering techniques and processes are likely to transform the food and agricultural system worldwide with great rapidity. That transformation is the result of twin processes that affect all scientific and technological innovation:

1. *Every technical change is also a social change.* This is illustrated by the fact that all new technologies that are put into practice, by definition change the behavior of other scientists, farmers, processors, wholesalers, retailers, and consumers.

2. *Every technical change is also a change in the distribution of social goods* such as income, wealth, power, status, and prestige. In particular for commodities with inelastic demand, new technologies are likely to alter the distribution of costs, benefits, and risks among the different kinds of actors (e.g., farmers, processors, retailers, etc.) as well as within particular classes of actors (e.g., between larger and smaller producers).

It follows that those involved in genetic engineering cannot divorce the social, economic, political and ethical consequences of their work from the scientific practices in which they engage.

Lawrence Busch (517) 355-3396; FAX (517) 336-2856

Sustainable Production Systems

Donald Wyse
Minnesota Institute for Sustainable Agriculture
St. Paul, MN 55108

Agriculture is going through a new era of change. This change has been stimulated by a mixture of environmental, social, and economic pressures caused by increased world competition, increased cost of production, soil erosion, degradation of water quality, and concern over the quality of rural life. These issues are forcing policy makers, agribusiness, university administrators, farmers, and agricultural scientists to question the sustainability of the current agricultural system.

Although many definitions have been proposed for sustainable agriculture, they all have one major concept in common, sustainable agriculture is a systems approach. Congress, in the 1990 Food, Agriculture, Conservation, and Trade Act, defined sustainable agriculture as an integrated system of plant and animal production practices having a site-specific application that will, over the long term: a) satisfy human food and fiber needs; b) enhance environmental quality and the natural resources base upon which the agricultural economy depends; c) make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; d) sustain the economic viability of farm operations; and e) enhance the quality of life for farmers and society as a whole.

Sustainable agriculture aims to incorporate the long-term maintenance of natural resources and agricultural productivity with minimal adverse environmental impacts, adequate economic returns to farmers, and the fulfillment of social needs of farm families and communities. In this regard, it often focuses on optimal crop production with minimal external inputs and the satisfaction of human needs for food and income. It considers not only economic values, but also cultural, community, and even household values.

Sustainable agriculture emphasizes reducing reliance on commercial inputs, particularly fertilizers and pesticides, by substituting management of internal resources. Lower external input systems must rely on practices such as crop rotations, integrated pest management, and diversified farming to maintain productivity and profitability. It emphasizes an integrated management system approach which emphasizes a multidisciplinary team approach to maintaining productivity and profitability while addressing the environmental and ecological concerns of society. Thus, sustainable farming systems have site-specific implications and focus on farming systems rather than individual farming practices.

Under the constraints of current federal farm policies crop producers perceive pests to be the major determent to the adoption of more sustainable cropping systems. Current farm policies encourage farmers to farm more land, use fewer internal inputs, use monocultures or short continuous rotations, and reduce tillage, all of which tend to support the development of high pest populations. If new, more sustainable cropping systems are to become a reality, they must be based on ecologically derived pest management technology, and the adoption of this technology must be supported by federal agricultural policy through incentives that reduce the risk of adoption by farmers.

The economic and environmental benefits of a diverse crop rotation are well known. Rotations increase the yield of most crops in a rotation over that of the crop grown in monoculture, decreases weed and disease levels, and in the case of perennial legumes, fix nitrogen and reduce soil erosion. So why don't farmers use crop rotations to manage weeds? The major reason is that current farm policies are tied to price supports for commodities, making diversification of cropping systems unprofitable. If crop rotations are to be used to manage weed problems in the future, the crops grown in rotation must be profitable.

Oat for Conservation and Non-Grain Uses

Steve R. Simmons
University of Minnesota
St. Paul, MN

There is much current interest in devising cropping systems that reduce environmental contamination and conserve soil. Oat has a long history of contributing to such goals in agriculture. Since Colonial times the oat crop has been a consistent feature on the American agricultural landscape. Its popularity historically has stemmed, in part, from its versatility. For example, oat was grown in eighteenth century New Jersey as a "standard spring crop" to be used any of three ways: as a companion crop to establish clover and timothy forages, as a hay crop in its own right when cut at an immature grain stage, and as a ripe grain crop. Oat grain was highly valued for draft horses at the time, and oat straw was considered more palatable for cattle than wheat or rye straw. Oat straw was also well-suited for making bed ticks for the farm home. In modern times, oat still provides an effective crop option for many farmers, particularly those who value it for more than its grain. Oat is an effective fall-sown, low-cost cover crop following row crops such as soybean or vegetables. Researchers found that after seeding oats into soybeans during mid-August in Iowa, surface vegetative residues in the fall were increased by about 20 percent over soybean fields with no oat cover. This additional residue significantly reduced the potential for soil erosion during fall and early-spring rains. According to a 1990 survey, oat was found to be the most frequently used crop in Minnesota for companion cropping during forage legume establishment. Evidence suggests that many farmers in other North Central states also prefer oats for companion cropping purposes. An effective companion crop must strike a balance between providing sufficient ground cover for erosion control and weed suppression without competing unduly with the young forage plants. Oat appears to achieve that balance very well, which likely accounts for its popularity. Oat also produces a highly desirable grain or forage (if harvested prematurely), which is especially attractive to dairy farmers. A traditional limitation of oat as a companion crop is its propensity to lodge and smother the underseeded legume. In fact, when asked how they would change their current companion crop cultivar, half of the respondents to the same 1990 survey indicated that they would most like to suppress lodging. Dwarf stature oat offers promise for improving companion cropping practices because of the dwarf's reduced lodging potential and its lower competitiveness with the undersown legume. Dwarf stature oat also was found to have a slightly higher feed value compared to conventional cultivars. A new dwarf oat cultivar ('Pal') has been recently released in Minnesota to service forage producers desiring improved companion cropping.

Steve R. Simmons (612) 625-3763, FAX (612) 625-1268

Competition - Wild and Cultivated Oats (Crop - Weed Interactions)

Beverly R. Durgan
Associate Professor and Weed Scientist
Department of Agronomy and Plant Genetics
University of Minnesota
St. Paul, MN 55108

Extensive research has been conducted on increasing crop tolerance to insects, diseases, and physiological stress. However, until recently, little research has been conducted on increasing crop tolerance (competitiveness) to weeds. Wild oat (Avena fatua L.) has been reported to be one of the most competitive weeds in small grains. Wild oat has also been reported to decrease yields in many other crops, including corn (Zea mays L.), soybeans (Glycine max (L.) Moench), and sunflower (Helianthus annuus L.). However, cultivated oats have been reported to be the least competitive of the small grains (barley > rye > wheat > oats).

Research was conducted to determine plant characteristics which might impart greater competitive advantage to cultivated oats, and that could be incorporated into a conventional oat breeding program to produce varieties with greater competitive ability. A modified additive model was used to study the ability of eight oat genotypes to compete with giant (Setaria faberii Herrm.) and green (Setaria viridis (L.) Beauv.) foxtail in field experiments in 1990 and 1991. The oat genotypes, representing a range of plant maturity, height, and morphology, were seeded at two planting dates. Oat genotypes were subjectively evaluated for plant growth type. Plant dry matter (above-ground biomass) of oats and foxtail was harvested at three oat growth states during the season. Foxtail growth was most suppressed by higher tillering "bushy" plant stature, non-dwarf genotypes, and was least suppressed by more upright, low-tillering genotypes and a dwarf genotype. Foxtail competition was more severe in the later planting date than in the early planting date. Based on these findings, further research should include: a more thorough examination of cultivated oat genotypes, measurement of interception of light into the oat canopy, and assessment of early oat growth to determine which genotype most rapidly close the crop canopy.

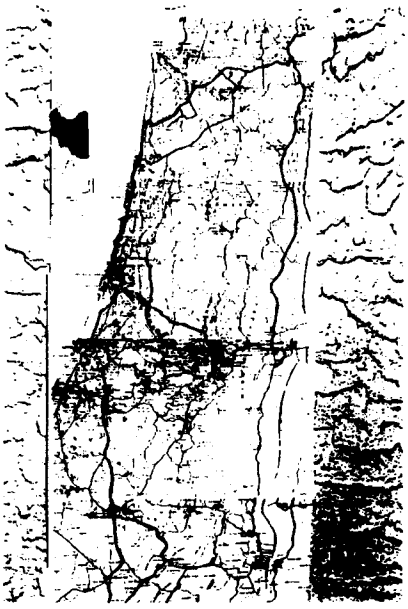
Increasing cultivated oats tolerance (competition) to weeds could decrease the need for herbicide applications, decrease production costs, and decrease environmental concerns due to the use of herbicides.

Beverly R. Durgan (612)625-7262, FAX (612)625-1268

WILD OAT COLLECTION--ISRAEL

Donald J. Schrickel, Retired, The Quaker Oats Co.
and
Deon D. Stuthman, University of Minnesota, St. Paul, MN

In order to find new sources of resistance to diseases in oats, an extensive collection of maturing seed of wild oat species was made in Israel in April and May, 1993. The most common wild oat species in Israel is *Avena sterilis* which can be found throughout the country, including the flower beds at the hotel in Tel Aviv and alongside the Wailing Wall in Jerusalem.



The map of Israel shows the numerous routes traveled, and it is well to note that collections were concentrated in the northern two-thirds of the country since the southern third is largely desert. The areas of collection were defined and directed by Dr. Yehoshua Anikster and Dr. Jacob Manisterski of the Institute for Cereal Crops Improvement, Tel Aviv University.

A total of 130 samples were collected and after clearance from U.S.D.A. will be entered into the research programs at the University of Minnesota and the U.S.D.A.-A.R.S., St. Paul, MN.

Donald J. Schrickel (602) 482-7566, FAX (602) 482-7566

EPIDEMIOLOGY OF OAT CROWN RUST

Alan P. Roelfs
USDA-ARS, Cereal Rust Laboratory
University of Minnesota
St. Paul, MN 55108

Crown rust has been an important disease of oats in North America for as long as records have been kept. Yield losses to crown rust were reported as early as the 1930's in Iowa where buckthorn, its alternate host, was common and in Texas where the crown rust fungus survives year-round. From 1950 to 1980, epidemics causing greater than 1% yield loss occurred in 17, 15, and 18 years in Minnesota, North Dakota, and South Dakota. Epidemics occurred most consistently during 1966 to 1974, when losses averaged 4.8, 4.5, and 2.9% in Minnesota, North Dakota, and South Dakota. Crown rust caused 32% loss in Texas in 1939 and 30% in Iowa in 1941 and 1953. Recent oat yield losses to crown rust include 10% in Iowa (1991, 1993); 20% in Minnesota (1991); and 15, 10, and 15% in South Dakota (1991, 1992, 1993). Epidemics in the northern Plains comes from aeciospores produced on buckthorn or from urediniospores blown in from the southern Plains. The relative importance of the two sources depends on the weather and the proximity of buckthorn to oat fields. The frequency of epidemics has generally decreased in Texas but increased in the northern Plains. Aecial infection on buckthorn in the northern Plains has increased. Buckthorn bushes are too widespread in the northern Plains to eradicate. Control of oat crown rust depends on the following in order of importance: putting multiple, effective resistance genes into oat varieties, eliminating the most susceptible varieties, removing buckthorn from around oat fields, and destroying infected straw from oat crops.

Molecular Markers and Partial Resistance to Plant Disease

Nevin D. Young, Vergel C. Concibido, Roxanne L. Denny, and James H. Orf
University of Minnesota, St. Paul, MN 55108

One of the most important applications of molecular markers in plant genetics is in characterizing the underlying genetics of complex traits. One type of complex trait amenable to study with genetic markers is partial disease resistance. Using genetic markers, the number and approximate map locations of partial resistance genes can be determined, as can the impact and gene action for each partial resistance locus. Moreover, the degree of 'race specificity' exhibited by partial resistance loci can be estimated by challenging a mapping population with different isolates of a disease pathogen. It may even be possible to examine the biological role of individual resistance loci or to carry out high resolution mapping as an entry point for positional gene cloning.

However, molecular markers suffer from limitations that are especially relevant in studies of complex characters. Molecular markers are still very expensive and complicated to use. It is often difficult to 'transfer' map locations for markers from one population to the next. Very large populations are required to uncover minor loci and populations may need to be tested in several environments or genetic backgrounds to provide useful information. Finally, mapping is necessarily constrained by the accuracy of the associated phenotypic scoring method.

Despite these constraints, we have examined resistance to the soybean cyst nematode (*Heterodera glycines*) using more than one hundred DNA markers in two F2 populations. Our results demonstrate that three to five loci play important roles in resistance, including one that controls as much as 60% of total variation. This major locus plus one of the other partial resistance loci exhibit significant race specificity; the other loci seem to act more independently of nematode race. Based on DNA genotype, lines carrying known combinations of resistance loci have been selected and may be useful in gene deployment and characterizing nematode races. We have also used DNA markers to develop lines with overlapping recombinations around the most important resistance locus as a prelude to high resolution mapping.

Nevin Dale Young (612) 625-2225; FAX (612) 625-9728; neviny@puccini.crl.umn.edu

Engineered Protection to Barley Yellow Dwarf Virus

Richard M. Lister, Jeffrey R. Vincent, Peter F. McGrath,
Brian A. Larkins[1], and Dave Somers[2]
Department of Botany and Plant Pathology, Purdue University,
West Lafayette, Indiana 47907-1155.
[1] Department of Plant Sciences, University of Arizona,
Tucson, Arizona 85721.
[2] Department of Agronomy and Plant Genetics, University of Minnesota,
St. Paul, Minnesota 55108.

The primary objective of this work is to obtain resistance to barley yellow dwarf virus (BYDV) in oats, and other cereals, by transformation with cDNAs encoding the BYDV coat protein. It is anticipated that cereal plants expressing this gene will exhibit coat protein-mediated resistance paralleling cross protection. To this end, the coat protein coding regions for the MAV-PS1, the P-PAV, and the NY-RPV serotypes of BYDV were identified and characterized from cDNA libraries derived from each of the respective virus isolates, and subsequently cloned into vectors suitable for gene expression in cereals.

Oat calli were co-transformed with constructs containing either the MAV-PS1, the P-PAV, or the NY-RPV coat protein gene, and the *bar* gene for herbicide resistance. Transformed callus tissue, initially selected for herbicide resistance, was then screened by PCR for the presence of the BYDV coat protein gene. From a number of the lines transformed with BYDV coat genes fertile regenerants were recovered. The progeny of these (R_1 plants) and subsequent generations (R_2 plants) are being tested for BYDV resistance. Transformed lines showing promising resistance to BYDV have been grown to the R_3 generation to evaluate whether the BYDV resistance is stably inherited, and to identify homozygous lines for subsequent introduction of the BYDV coat protein gene into oat breeding lines.

To test the transgenic plants for BYDV resistance, seedlings were infected with the homologous virus through the appropriate viruliferous aphid vector. Thus MAV-PS1 was transmitted by *Sitobion avenae*, P-PAV by *Rhopalosiphum padi*, and NY-RPV by *R. padi*. Virus transmission was allowed for at least 24 hours, at which time the aphids were killed with Malathion. Two weeks after inoculation, leaf tissue was sampled from individual plants and tested by specific ELISA for the BYDVs. Leaf tissue was also harvested for verification of the coat protein genes in the progeny by PCR. At the present time ca. 300 R_1 progeny and over 500 R_2 progeny have been tested by ELISA for BYDV resistance and some very promising individuals have been identified showing BYDV resistance. Similar experiments with barley are ongoing in collaboration with Dr. Peggy Lemaux, Plant Gene Expression Center, Berkeley/Albany, CA.

R.M. Lister (317) 494-4635, FAX (317) 494-0363, J.R. Vincent (317) 494-7791, FAX (317) 494-5896; P.F. McGrath (317) 494-9880, FAX (317) 494-0363.

Variability and Strain Specificity of Resistance to BYDV

Stewart M. Gray, Cathy Chay, Rick Vaughn and Dawn Smith
USDA-ARS,
Department of Plant Pathology,
Cornell University, Ithaca NY

The viruses that cause Barley Yellow Dwarf (BYD) are a group of related luteoviruses collectively known as Barley Yellow Dwarf Virus (BYDV). There are at least two distinct viruses, currently referred to as BYDV subgroup 1 and 2, and each virus can be further divided into several strains. Five distinct strains; PAV, MAV, SGV, RMV and RPV have been reported from North America. These strains and others have also been isolated from cereal and grasses around the world. The classification of strains was originally based on aphid vector associations; although, serological and nucleic acid-based assays are the principal diagnostic assays currently used by most researchers to identify BYDV strains. As the number of diagnostic tests and BYDV-specific reagents has expanded so has our ability to detect variants within each of the different BYDV strains. It is clear that BYD is caused by a diverse collection viruses and the taxonomy of the barley yellow dwarf luteoviruses will continue to expand and evolve.

Our recent work has examined the response of various spring oat genotypes to infection by isolates of BYDV representing the five strains found in North America. In addition, we have examined the diversity of isolates or variants within the PAV strain and the effects this diversity may have on efforts to accurately identify resistance to BYDV. Resistance or tolerance to BYDV has generally been assessed on the basis of symptoms induced in field grown plants by one isolate of the virus. Rarely are multiple isolates within or among strains used. Our findings generally agree with previous studies that a susceptible oat cultivar (e.g. 'Coast Black' or 'Astro') will show symptoms when infected with BYDV isolates representing the five strains, whereas oat cultivars or genotypes possessing some level of resistance to BYDV (e.g. 'Ogle' or IL86 5262) may show reduced or no symptoms. However our results indicated that symptom appearance or severity may not reflect the level of resistance or distinguish between resistant and tolerant plants. All possible combinations of symptom severity and levels of resistance were identified and resistance, identified as reduced virus accumulation, was found to be strain-specific.

The specificity of resistance may extend beyond the strain level. A single field of winter wheat in New York yielded a diverse group of BYDV isolates that were all initially identified as members of the PAV strain. Upon closer examination at least three distinct subgroups were identified based on restriction fragment length polymorphisms within the capsid protein gene sequences. Monoclonal antibodies were able to distinguish two PAV subgroups. Variability was also observed in the disease reaction of indicator hosts. The disease severity induced by three BYDV-"PAV" isolates was further examined in several spring oat cultivars as well as in a population of Ogle x Kanota genotypes. Results suggest that different loci are responsible for disease resistance to different "PAV" isolates. Furthermore, preliminary data indicate that these "disease resistance loci" can be further subdivided into virus resistance or virus tolerance loci.

Most Recent Version of the Oat Genome Map

L. S. O'Donoughue[1,4], S. Kianian[2], J. Rayapati[3], G. Penner[4],
M. E. Sorrells[1], S. D. Tanksley[1],
R. Phillips[2], H. Rines[2,†], M. Lee[3], G. Fedak[4], S. Molnar[4],
D. Hoffman[5], T. Salas[6], B. Wu[2], E. Autrique[1] and A. Van Deynze[1]

[1]Cornell University, Ithaca, NY; [2]University of Minnesota and † USDA-ARS, St. Paul, MN ; [3]Iowa State University, Ames, IA; [4]Plant Research Center, Ottawa, ON, Canada; [5]USDA-ARS-PWA, Aberdeen, ID; [6]North Carolina State University, Raleigh, NC

Progress towards the development of a molecular linkage map of cultivated oat is presented. Seventy one F6-7 recombinant inbred lines from a cross between *Avena byzantina* cv. Kanota and *A. sativa* cv. Ogle have been used as a mapping population. To date the Kanota x Ogle population has been characterized with 561 markers. These markers include mainly Restriction Fragment Length Polymorphisms (RFLP) detected by oat cDNA clones from leaf, endosperm and root tissue as well as barley leaf cDNA clones. These markers form 38 linkage groups ranging in size from 0.0 to 122.1 cM (mean: 39 cM) and consist of 2 to 41 markers (mean: 14). Twenty nine markers remain unlinked. The current map size is 1482.0 cM. It is estimated that approximately 50% of the cultivated oat genome is covered by this map. Comparisons with an A genome diploid oat map and comparisons between linkage groups exhibiting homoeology to each other, clearly indicate that several major chromosomal structural rearrangements exist in cultivated oat. This map already provides a tool for Quantitative Trait Loci analyses and studies of genome organization in oat.

Louise S. O'Donoughue (613) 995-3700, FAX (613) 992-7909

Application of Molecular Markers to Oat Improvement

Mark E. Sorrells
Cornell University, Ithaca, NY

The increasing number and cost of screening of traits that must be considered in variety development, especially those of low heritability, threatens to slow progress and restrict introgression of new germplasm. Molecular markers have the potential to increase the efficiency of variety development by improving the accuracy and predictability of parental genotype selection as well as by accurate selection of superior genotypes in segregating populations. Also, markers allow the simultaneous screening of several different traits without the need to apply various screening procedures to the population. Recently, my research has focused on the use of molecular markers to assess genetic variation and on the mapping of useful genes for marker-assisted selection. Reasons for my emphasis on marker-assisted breeding include i) cloning and transformation will not likely address all the needs of crop improvement but may complement other breeding methods and ii) cost of testing and release of genetically engineered varieties is well beyond most public programs. Objectives of our genetic relationship in oat studies are to develop appropriate methods of estimating genetic diversity among either cultivated or wild species, identify desirable parental genotypes, and develop methods of sampling germplasm for variety development. One possible germplasm sampling strategy is to select genotypes initially on the basis of useful agronomic characteristics or quality traits, and then select from those genotypes, a subset which are mutually dissimilar, on the basis of marker data. Quantification of genetic variation between individual genotypes used for hybridization could enhance the level of variation in breeding populations. More recently our studies have explored a new method of identifying potential loci controlling agronomic traits we refer to as ancestral chromosome tracking. This approach combines data accumulated from conventional yield trials or breeding nurseries, pedigrees, and molecular markers to identify those loci associated with particular traits. We are currently validating this methodology using results of quantitative trait mapping experiments. Our gene tagging work for BYDV resistance in oat has been a collaborative project with Fred Kolb and Charles Brown at the University of Illinois and with Stewart Gray at Cornell. We have identified several loci that control resistance to this virus but genotype by environment interaction and strain by genotype interaction have complicated the analyses. In addition, related traits such as height and vigor have confounded our scoring of BYDV symptoms. By scoring these related traits in the absence of the virus, we have identified loci that control those traits and separated them from "true" BYDV resistance loci. The development of comparative maps for species of the Gramineae family will allow researchers to link the genetics of our major cereal crops and will provide information critical to the efficient use of molecular marker technology in plant improvement. Research to date indicates that despite the dramatic changes in DNA content that have taken place since oat, rice, wheat, and maize diverged from their last common ancestor, many genes and linkage groups appear to have been conserved. Based on the comparative maps, it is possible to determine which regions of these genomes are homoeologous and to cross-access genetic information and mapping resources from one species to another. This information may facilitate the invention of unique quality traits and products.

Mark E. Sorrells (607) 255-1665, FAX (607) 255-6683

Recent Techniques in Oat Cytogenetics

Eric N. Jellen[1], Thomas S. Cox[1], Ronald L. Phillips[2], Howard W. Rines[3], and Bikram S. Gill[4]
[1]USDA-ARS and [4]Wheat Genetics Resource Center, Kansas State University, Manhattan, KS 66506.
[2]University of Minnesota and [3]USDA-ARS, St. Paul, MN 55108.

Cytogenetics includes the microscopic analyses of chromosome structure and genetic behavior. In recent years, powerful cytogenetic techniques such as C-banding and *in situ* hybridization have begun to be utilized in studying oats (*Avena sativa*, 2n=6x=42, AACCDD genomes) and other species of the genus *Avena*. When subjected to the C-banding technique, each of the 21 pairs of oat chromosomes was able to be identified and numbered for the first time based on its characteristic pattern of light (euchromatin) and dark (heterochromatin) bands. Chromosomes of the C genome were identified by their unique heterochromatic morphology, and evidence for the relationship of hexaploid oats to wild AACC putative progenitor *Avena* species was strengthened. When C-banding was coupled with genetic mapping data, the first homoeologous chromosome group assignments in oats were made. In addition, C-banding allowed for the identification of chromosome structural differences, including some translocations, between oat varieties (Sun II, Kanota, Ogle, Kherson, etc.) as well as related wild species (*A. fatua*, *A. sterilis*). Another technique, *in situ* hybridization to oat chromosomes with repeated sequence DNA probes, has been used to identify chromosomal locations of ribosomal RNA genes. A modification of this technique, genomic *in situ* hybridization (GISH), has been used to verify the assignment of oat chromosomes to A/D and C genomes. This technique has also identified intergenomic translocations involving seven or more pairs of chromosomes in the oat cultivar Ogle, including at least one that had not been previously detected using C-banding and one large interchange not found in Kanota. These cytogenetic techniques hold considerable potential for facilitating future mapping and exotic germplasm exploitation efforts by oat breeders and geneticists.

Rick Jellen, (913) 532-7260, FAX (913) 532-5692

International Germplasm Exchange

John Valentine, Shazia O.W.M. Reuben* and J. Desmond Hayes*
Institute of Grassland and Environmental Research
and *University of Wales, Aberystwyth
Aberystwyth, UK

The underlying theory of using wide germplasm is that genetically diverse parents contribute novel genes, increase the frequency of transgressive segregation and lead to greater genetic advance than could be obtained by crossing genetically similar parents. In the USA, the introduction of ancestral parents and the use of Milford for its stiff straw (in Clintford and Stout) and S172 for winter-hardiness genes (in Walken and Compact), and in the UK the use of Cimarron (in Lustre and Chamois) as a donor of several characteristics and an Illinois line (IL 36-1T-1T-3T) as a source of BYDV tolerance (in Melys) provide excellent examples of valuable germplasm transfers.

From a screen of spring oats from diverse locations, we selected eight lines (Pa 8598-18, IL 82-1657, IL 84-1431-1 and Valley from USA, OT 327, OT 329 and OA 698-2 from Canada and Hjan Valko from Finland). These were crossed with eight European lines in systematic fashion to initiate a recurrent selection programme for yield and earliness, presently in its second cycle. The genetic control of grain size and other characteristics have been studied in six of these lines (the three lines underlined above, the Australian line Mortlock and three of the eight European lines). Segregation in the F2 showed OT 329, IL 82-1657 and Mortlock to be useful contributors of genes for individual grain weight (on average, +3.8 mg compared to Melys), IL 82-1657 and Mortlock for earliness of panicle emergence (-11.4 days) and the dwarf Pa 8598-18 for short straw (-32.9 cms). Diallel analyses indicated that additive genetic variation was generally more important than that due to dominance, though a more detailed study of IL 82-1657 x 10589Cn and its backcrosses to each parent revealed appreciable amounts of non-allelic variation for individual grain weight and grains per panicle.

Using recurrent selection, the presence of fixable genetic variation is more important than identification of the best crosses. Efficient mechanisms of germplasm exchange are needed and precautions should be taken to avoid introducing non-endemic diseases and pests.

John Valentine (01144 970) 828255, FAX (01144 970) 828357

Wide Crosses Within *Avena*

Robert A. Forsberg* and Miglena Dilkova
University of Wisconsin-Madison
Madison, WI 53706

Reasons for embarking on an interspecific/interploidy crossing program in *Avena* include transfer of a specific gene(s) or for introduction of genetic diversity into the diploid, tetraploid, or hexaploid levels. Hybrids from crosses between species in the same ploidy level and with identical genome constitutions usually show complete bivalent pairing with chiasma, crossing over, and gene exchange. Reduced chromosome homology in hybrids from both intra- and interspecific crosses between species with different genome constitutions usually results in high univalent frequencies, complex pairing, lack of crossing over, and little or no gene exchange. Chromosome rearrangements over time have contributed to changes in chromosome and genome structure and to the existing differences between genomes and species.

In order to transfer desirable genes from diploids or tetraploids to hexaploids, the breeder/geneticist must accomplish the following steps: 1) achieve seed set in interspecific/interploidy crosses; 2) obtain F_1 plants which grow to maturity; 3) perpetuate transfer of the desired gene(s) from generation to generation by selfing and/or making additional crosses to a hexaploid parent; 4) incorporate the desired gene into an *A. sativa* genome; and 5) select stable, true-breeding lines for use as breeding stocks. The final challenge facing the oat breeder is to incorporate the "new" gene into a true-breeding genotype which also has high grain yield, stiff straw, multiple disease resistance, and high grain quality. Undesirable linkages, leading to unwanted correlated responses, and unpredictable gene interactions may further lengthen the time it takes to develop and release a worthy cultivar.

Four "Case Histories" provide examples of successful gene-transfer efforts: I. The irradiation of monosomic alien substitution lines carrying resistance to crown rust from *A. strigosa* (R. A. Forsberg, Wisconsin) or to stem rust from A. barbata (P.D. Brown, Manitoba). II. The irradiation of monosomic alien addition lines carrying resistance to mildew from *A. barbata* (T. Aung and H. Thomas, Welsh Plant Breeding Station). III. The incorporation of genes from diploid *A. longiglumis* line Cw 57 which interfere with the regular diploid-like meiotic pairing between homologous chromosomes by fostering pairing between alien chromosomes and their homoeologous chromosomes in *A. sativa*. Stable, mildew resistant breeding stocks were obtained (H. Thomas et al.). IV. Transfer of crown rust resistance from *A. strigosa* to *A. sativa* via octoploids (T. Aung, J. Chong (Manitoba) and H. Thomas). The uncontrolled chromosome breakage and perpetual meiotic disturbances in resulting translocation lines engendered by use of irradiation (Cases I and II) were avoided using the innovative methodologies of Cases III and IV.

Robert A. Forsberg (608) 262-1390, FAX (608) 262-5217

Oat Wide Hybrids Beyond *Avena*

Howard W. Rines*, Oscar Riera-Lizarazu, and Ronald L. Phillips
*USDA-ARS and University of Minnesota
St. Paul, MN 55108

Haploid plants of oat (*Avena sativa* L.) can be produced from crosses of cultivated oat (2n = 6x = 42) x maize (*Zea mays* L., 2n = 2x = 20) via maize chromosome elimination during embryo development, followed by embryo rescue. Haploid oat plants thus produced are partially fertile due to a meiotic restitution process generating viable gametes. Progeny of self-fertilized haploids generate 20 to 30% aneuploids, primarily monosomics (2n - 1), along with apparently normal disomic "doubled haploids." The aneuploids are being characterized with C-banding chromosomal staining and with molecular markers (RFLPs) to attempt recovery of a complete monosomic series in oat. In addition to the 21-chromosome haploid oats generated from the oat x maize crosses, about one-third of the recovered plants retain one (2n = 3x + 1 = 22) or up to four (2n = 3x + 4 = 25) maize chromosomes. Partial self-fertility in some 22- and 23-chromosome plants resulted in the recovery of 44-chromosome addition lines (2n = 6x + 2 = 44) disomic for a maize chromosome in an oat background. Maize RFLP probes are being used to identify the maize chromosome present in the addition lines. Maize chromosomes 3, 4, and 9 have been putatively identified in disomic addition lines. Maize chromosomes 2, 7, and 8 appear to be present in various self-fertile haploids and may yield additional disomic maize chromosome addition lines.

Howard W. Rines (612) 625-5220, FAX (612) 625-1268

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

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

Abel, Bryce C.
109 Plant Introduction
Iowa State University
Ames, Iowa 50011
(515)292-650

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

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

Albrechtsen, Rulon S.
Plant Science Dept.
Utah State University
Logan UT 84322
(801)7502243

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

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

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

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

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

Antonova, Nadejda
Inst.Intro. and Plant Genet. Res.
Sadovo 4122, Plovdiv
BULGARIA

Armstrong, Keith
DSIR Crop Research
Private Bag
Gore
NEW ZEALAND

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

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

Atkins, Dr. R. E.
Agronomy Department
Iowa State University
Ames, IA 50011-1010
(515)294-6863

Atkins, Mr. I. M.
208 Cottage Drive
Hereford, TX 79045

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

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

Baenziger, P. S.
Department of Agronomy
University of Nebraska-Lincoln
Lincoln, NE 68583-0915

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

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

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

Barradas, Manuel T.
Nat'l Plant Breeding Station
00-068-62847350 Elvas
PORTUGAL
Telex 40189 ENMP P

Beighley, Donn H.
Jacob Hartz Seed Co.
P. O. Box 946 N. Park Ave.
Stuttgart, AR 72160

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

Benvenuti, Antonio
Dipartmento Di Agronomia
Universita' degli Studi di Pisa
Via S. Michele degli Scalzi 2 -
56124 PISA ITALY

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

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

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

Betsinger, Signe T.
Administrative Advisor NCR-15
Univ. of Minnesota, 220 Coffey Hall
1420 Eckles Avenue
St. Paul, MN 55108

Bhatty, Ron
Crop Development Centre
Univ. of Saskatchewan
Saskatoon, Sask.
Canada S7N OWO

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

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

Black, Miss S. A.
Border Oats Ltd.
Edington Mill
Chirnside
Berwickshire UNITED KINGDOM

Bockelman, Harold E.
USDA-ARS, P. O. Box 307
Aberdeen, ID 83210

Bokenfohr, Vince
United Grain Growers Limited
Box 6030, Stn "C" 7410-120 Ave
Edmonton, Alberta T5B 4K5
Canada

Bollingberg, John
P.O. Box 111
Bremen, ND 58319

Brandu, Jay
Grain Millers, Inc.
P.O. Box 609
Hutchison, MN 55350

Brinkman, Marshall A.
2200 Westchester Road
Madison, WI 53711

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

Brockmueller,
RR2 Box 68
Freeman, SD 57029

Brodny, Dr. Uzi
Ins. for Cereal Crops Improvement
Tel-Aviv University
Ramat-Aviv, 69978
Tel-Aviv ISRAEL

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

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

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

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

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

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

Bruckner, Dr. Frantisek
Res. & Plt. Breeding Inst. of Cereal
767 01 Kr meriz, Havlickova 2787
CZECHOSLOVAKIA

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

Buraas, Trond
Bjorke Forsokgard
2344 Ilseng
NORWAY

Burnett, Dr. Peter A.
Agriculture Canada
Bag Service 5000
Lacombe, Alberta
CANADA TOC 1SO

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

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

Cahill, Anthony
National oats Company
Cedar Rapids, IA 52402

Campbell, Arden
Agronomy Department
Iowa State University
Ames, Iowa 50011

Canadian Grain Commission
Library
300 - 303 Main Street
Winnipeg, Manitoba
CANADA R3c 3G8

Cantrell, Ronald
Agronomy Department
Iowa State University
Ames, Iowa 50011

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

Carillanca, Biblioteca Estacion Exptl
Casilla 58-D
Temuco CHILE

Carr, Pat
Dickinson Research Center
P. O. Box 1117
Dickinson, ND 58602

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

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

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

Cebeco Zaden B.V.
Lisdoddeweg 36
Postbus 139 - 8200 AC Lelystad
HOLLAND

Central Sci. Agric. Library
Acquisition Librarian
Dept. of Intl Book Exchange
Moskow, B-139, Orlikov Per., 3
RUSSIA

Central Scient. Agric. Library
Foreign Publ.
Acquisitions/Exchange
Orlikov bystreet, 3, 107804, GSP
Moscow, B-139, USSR

Cervenka, Jaroslav
Plant Breeding Station
KRUKANICE
330 3G PERNAREC
CZECHOSLOVAKIA

Chaouki, Al Faiz
Dept. de Phytologi-FSSA
Pan Comtois Universite Laval
Quebec
Canada G1K 7P4

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

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

Choubey, R. N.
Division of Plant Improvement
Indian Grassland & Fodder
Res. InstituteJhansi 284003
INDIA

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

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

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

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

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

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

Codema Inc.
11790 Troy Lane North
Minneapolis, MN 55369-9377

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

Corseuil, Elio
Rua Paulo Polita
33 - Petropolis
Passo Fundo
BRAZIL CEP 99050

Coutinho, Jose
National Plant Breeding Station
7351 Elvas Codex
PORTUGAL

Cretney, Jim B.
Robin Hood Multifoods Inc.
1040 - 167 Lombard Ave.
Winnipeg, Manitoba R3R 2Y3

Dahleen, Lynn
USDA-ARS
Northern Crops Science Laboratory
NDSU, Fargo, ND 58105

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

Deparement of Agriculture
Librarian
Baron-Hay Court
South Perth, W. A. 6151
AUSTRALIA

Dhukia, Dr. R.S.
201, Defence Colony
Hisar (Haryana) -125 001
INDIA

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

Dinoor, Amos
Dept. of Plant Path & Microbio.
Faculty of Agriculture
P. O. Box 12
Rehovot 76100 ISRAEL

Doehlert, Doug
Cereal Science & Food Tech Dept.
North Dakota State University
Fargo, ND 58105

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

Dorigoni, Regina
Quaker, Apdo Postal 2795
Guatemala
CENTRAL AMERICA

Dragoljub, Maksimovic
Institute of Small Grains
3400 Kragujevac
YUGOSLAVIA

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

Dubuc, J. P.
2560, boul. Hochlega
Sainte-FoyQuebec
Canada G1V 2J3

Duerst, Donald D.
Agronomy Dept.
University of Wisconsin
Madison, WI 53706 (608)262-1650

Dyck, Philip
Camp Agric. Exptal Sierra de Chih
Apdo Postal 554
CD Cuauhtemoc Chih 31500
Mexico

Eagles, H. A.
VIDA
Private Bag 260
Horsham Vic 3400
AUSTRALIA

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

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

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

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

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

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

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

Federizzi, Luiz Carlos
Faculdade de Agronomia - UFRGS
Caiza Postal 776
90001 Porto Alegre (RS)
BRASIL

Fernholz, Carmen
RR2 Box 9A
Madison, MN 56256

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

Fisova, Ing. Hana
Plant Breeding Station
593 01 Bystrice nad Pernstejnem
Zdar nad Sazavou
CZECHOSLOVAKIA

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

Flahavan, John E.
Flahavan & Sons Limited
Kilmacthomas County Waterford
IRELAND 051-94107

Fleig, Darlene
Agronomy Department
Iowa State University
Ames, Iowa 50011

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

Forestry Library
Central Agricultural and
Slezska 7
120 56 Praha 2
CZECHOSLOVAKIA

Forsberg, Dr. Robert A.
Dept. of Agronomy
University of Wisconsin
Madison, WI 53706
(608)262-1390

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

Fraleigh, Dr. Brad
P.G.R.C., Biosystematics Res.
Centre Wm. Saunders Bldg., C.E.F.
Research Branch, Ag Canada
Ottawa, Ontario, Canada K1A 0C6

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

Freeman, Kenneth
Twyford Seeds Ltd, Pl. Breeding
Scott's Farm, King's Sutton
Banbury, Oxon 0X16 9BQ
UNITED KINGDOM

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

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

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

Fyffe, Alistair
Quaker Oats Ltd.
Cupar, Fipe
KY15 4DD
SCOTLAND

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

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

Galway, D. A.
Agriculture Canada Plant
Research Center, Bldg. 75
Ottawa, Ontario Canada K1A 0C6

GanBmann, Dr. W.
Postfach 640 2200
Elmshotn GERMANY

Gardenhire, James H.
607 Mimosa
Denton, TX 76201

Gehl, Dave
Experimental Farm
P.O. Box 760
Indian Head, Saskatchewan
Canada S0G 2K0

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

Gerrand, Karl
P. O. Box 520
Portage La Prairie, Manitoba
Canada R1N 3B9

Gilbert, Gerhard
Cabec Intl Corp.
1607 - 116th Ave. N.E., Suite 105
Bellevue, WA 98004

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

Gilmore, Dr. Earl C.
Texas A&M Univ. Agric Res Ctr
P. O. Box 1658
Vernon, TX 76384

Goellner, C. I.
Rua Paulo Polita
33 - Petropolis
Passo Fundo
BRAZIL CEP 99050

Goetze, Dorothea
Saatzuchtstation Salzmunde
Salzmunde GERMANY 4101

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

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

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

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

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

Gray, Dr. S. M.
Department of Plant Pathology
307 Plant Sci. Bldg.
Cornell University
Ithaca, NY 14853

Green, Mrs. J.
John Innes Institute
Colney Lane
Norwich NH4 7UH
ENGLAND

Green, Christopher
Semundo Limited
Unit 55, Clifton Road
Cambridge CB1 4FR
UK

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

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

Gullord, Magne
Apelsvoll Research Station
N-2858 KAPP
NORWAY

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

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

Hagberg, Per
Svalof Ab
S-26800 Svalov
SWEDEN

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

Halstead, Richard P.
Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55108

Hanzel, James J.
Crop and Weed Sciences Dept.
North Dakota State University
Fargo, ND 58105

Harder, D. E.
Research Station
195 Dafoe Rd
Winnipeg, Manitoba
Canada R3T 2M9

Harding, Mrs. S.
Twyford Seeds Ltd, Plant Breeding
Scott's Farm, King's Sutton
Danbury, Oxon 0X16 9BQ
UNITED KINGDOM

Hardman, Leland L.
Agronomy & PI Genetics Dept.
411 Borlaug Hall
University of Minnesota
St. Paul, MN 55108

Harrison, Stephen A.
Dept. of Agronomy
221 M.B. Sturgis Hall
Louisiana State University
Baton Rouge, LA 70803-2110

Harrold, Robert
Animal Science Dept.
North Dakota State University
Fargo, ND 58105

Hasan, Badrul
S.K. Univ. of Agric. Sciences
P.O. Box 706, G.P.O.
Srinagar, Keshim
INDIA 190 001

Hayes, Prof. J. D.
Univ. College of Wales
Dept. of Agriculture
Penglais Aberystwyth Dyfed SY23,
3DD UNITED KINGDOM

Hayward, M. D.
Crop Improvement Division
Walsh Plant Breeding
Plas Gogerddan Near Aberystwyth
Wales, UNITED KINGDOM

Helm, Dr. James
Crop and Weed Sciences Dept.
North Dakota State University
Fargo, ND 58105-5051

Henderson, Pat
American Oat Association
415 Shelard Parkway
Suite 101
Minneapolis, MN 55426

Henson, Dr. Cynthia A.
Dept. of Agronomy
University of Wisconsin
Madison, WI 53706

Herrman, Dr. Matthias H.
Institut Fur Zuchtung
Landwirtschaftlic. Kulturpflanzen,
Institutsplatz D-O 2551 Gross
Lusewitz GERMANY

Hewing, Anna
Agronomy Dept.
University of Illinois
Urbana, IL 61801

Himschoot, Dennis A.
United Grain Growers, Seed
Division 7410 - 120 Avenue
Edmonton, Alberta,
Canada T5B 4K5

Hoffman, David
University of Idaho
R & E Center
P. O. Box 307
Aberdeen, Idaho 83210

Hoffman, Linwood
USDA Economic Research Service
Rm 1034-A
1301 NY Ave. NW
Washington, DC 20005-4788

Holden, John
The Steading Yarrow Selkirk
SCOTLAND

Holland, J.B.
Box 7620
NCSU
Raleigh, NC 27695

Holownia, Myrna
Oat Producers Assoc. of Alberta
No. 304,7000 - 113 Street
Edmonton, Alberta T6H 5T6
Canada

Hoppe, Heinz-Dieter
Inst. fur Zuchtungsforschung
Quedlinburg Neuer Weg 22/23
0-4300 Quedlinburg GERMAN
DEMOCRATIC REPUBLIC

Horton, Geraldine R.
Quaker Oats Research Library
617 W. Main Street
Barrington, IL 60010

Hughes, Mark E.
Cereal Rust Laboratory
University of Minnesota
St. Paul, MN 55108

Hurt, H. David
The Quaker Oats Company
617 West Main St.
Barrington, IL 60010

Information for Agriculture
Institute of Scient. & Tech.
20 56 PRAHA 2Slezska 7
CZECHOSLOVAKIA

Inst. International Rice Research
Library & Documentation Ctr.
P O Box 933
Manilla, PHILLIPINES

Iriki, Norio
Agronomy Dept.
Hokkaido Nat. Agr. Exp. Sta.
Hitsujigaoka, Toyohira
Sapporo 004, JAPAN

Irving, Delilah W.
Western Regional Research Center
800 Buchanan Street
Albany, CA 94710

Jallagher, Jacqueline D.
Assoc Ed., DIVERSITY Magazine
727 8th St. S.E.
Washington, D.C. 20003

Jarrett, R. E.
Crop Science Dept.
North Carolina State Univ.
Raleigh, NC 27695-7620

Jatasra, Dr. D. S.
Dept. of Plant Breeding
Haryana Agricultural University
Hisar - 125 004
INDIA

Jeffrey, Russell
Box 6030, Stn "C"
7410 - 120 Avenue
Edmonton, Alberta, Canada T5B 4K5

Eric Jellen
USDA/ARS
Dept. of Agronomy
Kansas State Univ.
Manhattan, KS 66506

Jensen, Neal F.
5416 Thomas Court N.E.
Albuquerque, NM 87111

Jensen, Nancy
Seed Laboratory
Sturtevant Hall
NYS Agric. Expt. Station
Geneva, NY 14456

Jimenez, Ing Gerardo Valdes
U A A A N Programa De Cereales
Buenavista
Saltillo COAH
MEXICO

Joannides, Christine
Victorian Crops Research Institute
Natimuk Road Private Bag 260
Horsham, Victoria 3400
AUSTRALIA

Johannesmeyer, Jeff
Nine ConAgra Drive
P.O. Box 3100
Omaha, NE 68103-0100

Johnson, David R.
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Jones, I. T.
Pathogen & Pest Resistance Group
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
SY23-3EB, Wales, UK

Jones, J. E.
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
SY23-3EB Wales, UNITED KINGDOM

Jordan, N.
Twyford Seeds Ltd.
Kings Sutton, Banbury
Oxon 0X17 3QWENGLAND

Karow, Russ
Crop Science Bldg., Rm 131
Oregon State University
Corvallis, OR 97331-3002

Katiyar, D. S.
Scientist-S2
Indian Grass. & Fod. Res. Inst.
Jhansi, INDIA 284003

Kavanagh, Prof. James A.
Dept. of Environmental Resource Mgmnt. Agriculture Faculty
University College Dublin 4
IRELAND

Keane, P. J.
Latrobe University
Botany Dept.
Bundoora Victoria
AUSTRALIA 3083

Kelly, Cal
Oat Marketing & Research Head
Office, 499 Hoffer Drive
Regina, Saskatchewan S4N 6E2
Canada

Kianian, Shahryar
Agronomy & Plant Genetics
411 Borlaug Hall
University of Minnesota
St. Paul, MN 55108

Kibite, Solomon
Agriculture Canada
Lacombe Research Station,
Bag #5000 Lacombe, Alberta
Canada T0C 1S0

Kirkby, R. L.
The Oats Marketing Board
Box R196, P O Royal Exchange
Sydney N.S.W.
AUSTRALIA

Kirton, A. E.
Canadian Wheat Board
423 Main St.
Box 816
Winnipeg, Canada R3C 2P5

Kishor, Dr. C.
Department of Plant Breeding
Haryana Agricultural University
Hisar - 125 004
INDIA

Klinck, Dr. H. R.
MacDonald Campus of McGill Univ.
21111 Lakeshore Road
Ste Anne De Bellevue,
P Quebec H9X 1C0

Knezevic, Desmir
Institute for Small Grains "Kragujevac" in Kragujevac
S. Kovacevica 31. 3400 Kragujevac
YUGOSLAVIA

Kolb, Frederic L.
Agronomy Department
University of Illinois
Urbana, IL 61801

Kolln, Peter
Postfach 640 2200 Elmshotn
WEST GERMANY

Konzak, C. F.
Agronomy Department
Washington State University
Pullman, WA 99164

Koster, Kevin
RR2 Box 202
St. Ansgar, IA 50472

Kostov, Kiro Dimov
Plant Introduction Inst.
Sadavo
Plovdiv, BULGARIA

Krenzer, Gene
Dept. of Agronomy
Oklahoma State University
375 Agricultural Hall
Stillwater, OK 74078

Kristiansson, Bo
Svalof AB S-268 00
Svalov, SWEDEN

Krivchenko, Professor T. I.
All-Union
Institute of Plant Production
Leningrad - Pushkinul.
Gercena 44 USSR

Kumagai, Takeshi
Hokkaido Nat Agr Exp Sta
Higashi 1 jo 10 chome 2-15
Tsukisamu, Toyohira
Sapparo 062, JAPAN

Kumar, J.
Hill Campus
G.B.Paut
Ranichuri 249199
Tehri (U.P.) INDIA

Kummer, Dr. Manfred
Institut fur Zuchtungsforschung
Neuer Weg 22/23
0-4300 Quedlinburg
GERMANY

Kushnak, Greg
Agr Research Center
P O Box 1474
Conrad, MT 59425

Kuuts, Hans
The Jogeva Plant Breeding Station
202 350 Jogeva
Estonian SSR
USSR

Ladizinsky, Gideon
Faculty of Agriculture
The Hebrew University
P. O. Box 12
Rehovot, ISRAEL

Lafever, Dr. H. N.
Agronomy Dept.
Ohio Agr. Res. & Dev. Ctr.
Wooster, OH 44691

LaGrouw-Soeteman, J.
Plant Breeding Station
Cebeco Zaden B.V.P.O.
Box 139 8200 AC Lelystad
THE NETHERLANDS

Lamas, Salvador Galran
Calle 4a. N. 262
Apdo. Postal N 554
Cd. Cuauhtemoc, Chih.
MEXICO

Lamey, Arthur
Plant Pathology Dept.
North Dakota State University
Fargo, ND 58105-5012

Lampinen, Risto
Exp. Farm of K-Group
Hahkiala
SF-14700 HAUHO
FINLAND

Lane, Michael
Pillsbury
P.O. Box 2906 Peavey Co.
Minneapolis, MN 55402

Lapp, William
Con-Agra Inc.
Con-Agra Center
#1 Central Park Plaza
Omaha, NE 68102

Larson, Warren
University of Alaska
Fairbanks Coop. Extension Service
34820 College Dr., Suite 2
Soldotna, AK 99669

Lawes, D. A.
Welsh Pl Breed Station
Plas Gogerddan Near Aberystwyth
SY23-3EB Wales
UNITED KINGDOM

Lazar, Dr. Mark
Texas A&M Agric Res Ctr at
Amarillo
6500 Amarillo Blvd West
Amarillo, TX 79106

Lea, Philip
Morning Foods Limited
Northwestern Mills
Crewe, CW2 6HP
Cheshire, ENGLAND

Leath, Steven
Dept. of Plant Pathology
Box 7616, NCSU
Raleigh, NC 27695-7616

Lee, Dr. Michael
Department of Agronomy
Iowa State University
Ames, Iowa 50011

Legarreta, Manuel
Ramirez Cambo Experimental,
Sierra de Chihuahua Hildago
#1213, APDO Postal 554
Cuahtemoc, Chih. MEXICO

Leggett, J. M. Welsh
Plant Breeding Sta.
Plas Gogerddan
Aberystwyth
Dyfed UNITED KINGDOM

Leist, Norbert
Lufa-Augustenbberg
Nesslerstrasse 3
D-7500-Karlsruhe 41
WEST GERMANY

Lenz, Marvin
Quaker Oats Co.
617 W Main St.
Barrington, IL 60010

Leonard, Kurt
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Library
Alberta Agriculture
J. G. O'Donoghue Building
7000 - 113 Street Edmonton,
Alberta, T6H 5T6 Canada

Library
Albert R. Mann
Acquisitions Division
Cornell University
Ithaca, New York 14853-4301

Lister, R. M.
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

Livingston, David
USDA, ARS
U. S. Regional Pasture Lab
Curtin Rd.
University Park, PA 16802

Lobson, Carolyn
1470-360 Main St.
Winnipeg, Manitoba R3C 3Z3
Canada

Long, David L.
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Longauer, Ing. Igor
Plant Breeding Station
962 02 Viglas, okres Zvolen
CZECHOSLOVAKIA

Lookhart, Dr. G.
USDA
1515 College Ave.
Manhattan, KS 66502

Loskutov, Dr. Igor G.
N.I. Vavilov Inst. Plant Industry
44, Herzen Str., I 90000
St. Petersburg RUSSIA

Lottie, Raymond
General Mills, Inc.
P.O. Box 15003
Minneapolis, MN 55145

Loya, L.
RamiroCalle 37 Y Ferrocarril
CD. Cuauhtemoc, Chic.
MEXICO

Luetkemeier, O. W.
Agronomy Dept.
Purdue University
Lafayette, IN 47907

Lundin, Marianne
W Weibull AB
Box 520, S-261 24
Landskrona
SWEDEN

Lyzlov, E. V.
Agricultural Research
Institute Nonchernozeme Zone
143013 Nemchinowka-1
Moscow Region, USSR

Macas, Benvindo Martins
National Plant Breeding Station
7351 Elvas Codex
PORTUGAL

Mackay, M. C.
Australian Winter Cereals
Private Mail Bag, R M B 944
Tamworth, N.S.W.
AUSTRALIA 2340

MacKey, James
Swedish Univ. of Agr. Science
POB 7003, S-750 07 Uppsala
SWEDEN

Mai, W. F.
Plant Pathology Dept.
Plant Science 310
Cornell University
Ithaca, NY 14853

Maksimovic, Dragoljob
Institute for Small Grains
34 000 Kragujevac
YUGOSLAVIA

Maldonado, Uriel
Santa Monica No. 19-2
Colonia Del Valle
03100 Mexico D.F.
MEXICO

Malecha, Michael F.
Ralston Purina Co.
P. O. Box 3588
Davenport, IA 52808

Manchanda, P. L.
Cummings Laboratory, Div.of
Genetics
IARI
New Delhi 110012 INDIA

Manisterski, Jacob
Institute Cereal Crops Improvement
Tel-Aviv University
Ramat Aviv
Tel-Aviv, 69978 ISRAEL

Market Analysis Division
P. O. Box 6200
Winnipeg, Manitoba Canada
R3C 4N1

Marshall, Dr. H. G.
R.D. 2, Box 230
Bellefonte, PA 16823

Marshall, David S.
Texas A&M Univ. Res.
& Ext Ctr at Dallas
17360 Coit Road
Dallas, TX 75252

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

Martin, Jim
LaCrosse Milling Co.
Cochrane, WI 54622

Martinez, Jose Luis Morales
Calle 30 # 4812 Col. Dale C.P.
31050
Chihuahua, Chih. Mexico

Mather, Dr. D. E.
Plant Science
Macdonald College of McGill Univ.
21,111 Lakeshore Rd Ste-Anne-de-
Bellevue, Quebec H9X 1C0

Mattsson, Bengt
Svalof AB 268 00
Svalof, SWEDEN

Maughan, Miss J.E.
Western Australian Dept. of Agriculture
Baron-Hay Court South
Perth 6151, Western Australia

Mazaraki, Maria
Plant Breed Institute
30-423 Cracow
4 Zawila Str
POLAND

McDaniel, Dr. M. E.
Soil & Crop Sciences Dept.
Texas A & M University
College Station, TX 77843

McEwan, J. M.
Crop Research Division
D SIR, Private Bag
Palmerstown North
NEW ZEALAND

McFerson, John
Asgrow Seed Co.
1060 E. Highway 14, RR #1
Janesville, WI 53546

McGriff, Terry
North Central Res. Ext. Center
Rt 3, Box 174
Minot, ND 58701

McKendry, Anne L.
Department of Agronomy
106 Curtis Hall
University of Missouri
Columbia, MO 65211

McKenzie, Dr. R.I.H.
Agriculture Canada Research Station
195 Dafoe Road
Winnipeg, Manitoba R3T 2M9

McLean, R. J.
W. Aust. Dept. of Agriculture
Baron-Hay CRT
South Perth 6151
WESTERN AUSTRALIA

McMullen, Mike
Crop and Weed Sciences Dept.
North Dakota State University
Fargo, ND 58105-5051

McMullen, Marcia V.
Plant Pathology Dept.
North Dakota State University
Fargo, ND 58105

Medeiros, Renato Borges De
Av. Panamericana, 337/302
91.050 - Porto Alegre - RS
Brasil

Michel, Leonard
77 Westbury Drive
Bella Vista, AR 72714

Micke, A.
Plant Breeding & Genetic Sect
FAO-IAEA Divisions
P O Box 100 A-1400 Vienna
AUSTRIA

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

Mikkelsen, K.
Norwegian Grain Corporation
P.O. Box 5054, N-1501 Moss
NORWAY

Mikoska, Ing. Pavel
Res. & Plt. Brdg. Inst. of Cereals
767 01 Kromeriz Havlickova 2787
CZECHOSLOVAKIA

Miller, J. D.
Plant Pathology Dept.
North Dakota State Univ.
Fargo, ND 58105

Miller, Dr. W. Allen
Dept. of Plant Pathology
Iowa State University
Ames, Iowa 50011-1020

Mishra, S. N.
Dept. of Plant Breeding
G. B. Pant Univ Agr & Tech
Pantnagar 263145(U.P.) INDIA

Misri, Dr. Bimal
Indian Grass & Fod Res Inst.
Manasbal 196 504
J & K State
INDIA

Mlinar, Rade
Inst. for Breeding & Prod. Field Crops
41000 Zagreb Marulicev trg 5/I
YUGOSLAVIA

Monzon, Rene
Torre Profesional II - Of. 411
Centro Comercial Zona 4
P. O. Box 2795
Guatemala, Guatemala, C. A.

Morgan, George H.
Small Grains Bldg.
Agronomy Dept.
Oklahoma State University
Stillwater, OK 74078

Morikawa, Toshinobu
Lab of Genetics & Plant Breeding
College of Agriculture
University of Oscka Prefecture
Sakai, Osaka 591 JAPAN

Moser, Hal
Agronomy Department
Iowa State University
Ames, IA 50011

Mowder, Jimmie
USDA/ARS/DA/PGGI
BARC-W, Bldg. 001, Rm 130
Beltsville, MD 20705

Mulkey, J.
1619 Garner Field Rd
Uvalde, TX 78801

Muller, Dr. Kurt
VEG Saatzucht Petkus
Institut fur Getreidezuchtung
1711 Petkus
GERMANY

Munchen, Technische
Universitat Lehrstuhl fur Pflanzenbau und Planzenzuchtung
805 Freising-Weihenstephan
GERMANY

Mundt, Chris
Dept. of Botany & Plant Pathology
Oregon State University
Corvallis, OR 97331-2902

Munk, Aage
Landbrugents Kornforaedling
Noerremarksveg 67 Sejet
Dk 8700 Horsens
DENMARK

Murai, Koji
Takarazuka Research Center
Sumitomo Chemical Co.
Ltd4-2-1 Takatsukasa
Takarazuka, Hyogo 665 JAPAN

Murphy, Paul
Crop Science Dept.
North Carolina State Univ.
Raleigh, NC 27695-7620

Murphy, Dr. Charles F.
USDA, ARS, NPS
Bldg. 005, BARC-W
Beltsville, MD 20705

Nacional Estacao
De Melhoramento de Plantas
ATTN: J. Contusky Elvas
PORTGUAL

Nassuth, Annette
Botany Department
University of Guelph
Guelph, Ontario Canada N1G 2W1

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

Navarro-Franco, Manuel
INIFAP-CIAMEC
Apdo Postal No 10
56230 Chapingo, Mex
MEXICO

Nelson, Dr. Lloyd
Texas A&M Univ.
Agric.Res.Ctr at Overton
Drawer E
Overton, TX 75684

Niekert, H. A. Van
Private Bag X29
Bethlehem 9700
REPUBLIC OF SOUTH AFRICA

Niemansverdriet, W. C.
Instituut Voor Plantenveredeling
PostBus 386
6700 AJ Wageningen
NETHERLANDS

Noll, Dr. John
Agriculture Canada
195 Dafoe Road
Winnipeg, Manitoba Canada
R3T 2M9

Nutter, Dr. Forrest
Dept. of Plant Pathology
Iowa State University
Ames, Iowa 50011-1020

Oat Examiner
Plant Variety Protection Office
Science Division, AMS, USDA
Natl. Agric. Library, Rm 500
Beltsville, MD 20705

Oates, J. D.
Pl. Brdg. Inst.
P. O. Box 180
Castle Hill-University of Sydney
N.S.W. 2154 AUSTRALIA

Oberthur, Laura E.
Department of Agronomy
University of Nebraska-Lincoln
Lincoln, NE 68583-0915

Ohm, Dr. H. W.
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

Oliver, W. H.
P. O. Box 148
Lindfield 2070
NSW, AUSTRALIA

Oplinger, Edward S.
Agronomy Dept.
363 Moore Hall
University of Wisconsin
Madison, WI 53706

Osbourn, A.
The Sainsbury Laboratory
Norwich Research Park
Colney, Norwich, NR4 7UH
UK

Ozeki, Yukio
Hokkaido Nat. Agr. Exp. Sta.
Hitsujigaoka, Toyohira
Sapporo 004, JAPAN

Pakendorf, K. W.
Small Grain Centre
Private Bag X29
Bethlehem 9700
Republic of South Africa

Palagyi, Andras
Cereal Research Institute
H-6701 SZEGED
P O Box 391
HUNGARY

Paliwal, Y. C.
Chem & Biology Res Inst.
Research Branch, Canada Agric.
Ottawa, Ontario Canada K1A 0C6

Park, Byung-GunSeoul
Nat'l University
Agronomy Department
103 Seodun-dong, Kyunsun-Gu
SUwon 441-744, SOUTH KOREA

Paroda, R. S.
Dept. of Plant Breeding
Haryana Agricultural University
Hissar INDIA 12500-4

Parry, Anna L.
Plant Pathology Dept.
Welsh Plant Breeding Station
Plas Goggerddan Near Aberystwyth
S&23-3EB Wales, U.K.

Pass, H.
Agronomy Dept.
Oklahoma State University
Stillwater, OK 74074

Patil, B. D.
Indian Grassland & Fodder
Res.Inst.
Pahuj Dam, Jhansi-Gwalior
RdJhansi-284003 (U P) INDIA

Patrick, George
Agronomy Dept.
Iowa State University
Ames, Iowa 50011-1010

Patterson, F. L.
Agronomy Dept.
Purdue University
W. Lafayette, IN 47907

Payne, Thomas S.
CIMMYT P.K. 39 EMEK
Ankara, TURKEY

Pederson, Bill
Atwood-Larson Co.
876 Grain Exchange
Minneapolis, MN 55415

Perdue, Robert E.
ARS, USDA
Room 366, Bldg. 001
BARC-West
Beltsville, MD 20705

Perez, Dr. Federico Cuevas
Instituto Superior de Agricultura
Apartado de Correos 166
La Herradura Santiago
Dominican Republic

Peterson, D. M.
Agronomy Dept.
University of Wisconsin
Madison, WI 53706

Pfahler, P. L.
Agronomy Dept.
304 Newell Hall
University of Florida
Gainesville, FL 32611

Phillips, R. L.
Dept. of Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55108

Pierre, C. A. St.
Agriculture Canada
2560 Boul Hochelaya
Sainte-Foy
Quebec, Canada

Podyma, Wieslaw
National Dept. of Plant Genetic Resources
Plant Breeding and Acclimatization
Inst. 05-870 Blonie POLAND

Poehlman, J. M.
Dept. of Agronomy
109 Curtiss Hall
University of Missouri
Columbia, MO 65211

Polsoni, L.
Crop Science Department
University of Guelph
Guelph, Ontario Canada

Portmann, Peter
Dept. of Agriculture
Jarrah Road
South Perth
AUSTRALIA WA 61S 1

Postoyko, J.
Dept. of Biological Sciences
John Dalton Building
Manchester Polytechnic
Oxford Road, Manchester, U.K.

Powers, Rebecca
Agronomy Department
Iowa State University
Ames, Iowa 50011

Premachandran, M. N.,
Indian Grassland & Fodder Res Inst., Pahuj Dam
Jhansi-Gwalior Road
UP INDIA 284 003

Qualset, Dr. C. O.
Plant Science
Univ. of California-Davis
Agricultural Experiment Station
Davis, CA 95616

Quiroz, Dr. Alfredo Carballo
Centro de Genetica
Colegio de Postgraduados
Apdo Postal 1
Chapingo, MEXICO CP 56230

Rabb, James L.
Red River Research Station
Box 8550
Bossier City, LA 71113

Ramirez, Ignacio
Instituto de Investigaciones Agropecuarieas
Casilla 5427 / La Platina
Santiago, CHILE

Ramslan, Mark
Burdick Grain Co.
730 2nd Ave. S.
Minneapolis, MN 55402

Rao, M. V.
Wheat Project Director
IARI
New Delhi, INDIA 11001-2

Rayapati, P. John
Department of Agronomy
Iowa State University
Ames, Iowa 50011

Reagan, Marty
International Multifoods Inc.
Multifoods Tower,
33 South 6th Street, Box 2942
Minneapolis, MN 55402

Reeves, Dale L.
Plant Science Dept.
South Dakota State University
Brookings, SD 57006

Reich, Dr. V. H.
Agronomy Dept.
University of Tennessee
Knoxville, TN 37901

Reinbergs, E.
Crop Science Dept.
University of Guelph
Guelph, Ontario Canada N1G 2W1

Reitan, Lars
Statens Forskingsstasjon Kvithamar
7500 Stjordal
NORWAY

Rekunen, Matti
Hankkija Plant Breeding Inst.
SF-04300 Hyryla
FINLAND

Reynolds, Dr. Daniel B.
LSU N.E. Exp. Station
P. O. Box 438
St. Joseph, LA 71366

Reysack, James
Agronomy & Plant Genetics
411 Borlaug Hall
1991 Buford Circle
St. Paul, MN 55108

Rines, Howard W.
Agron & Plant Genetics Dept.
303 Agronomy Bldg.
University of Minnesota
St. Paul, MN 55108

Riveland, Neil
Williston Branch Station
Box 1445
Williston, ND 58801

Roberts, G.
Temora Agric. Research Sta.
P O Box 304
Temora, N S W 2666
AUSTRALIA

Robertson, Larry
Ext. Crop Management Specialist
University of Idaho
P. O. Box AA
Aberdeen, ID 83210

Robin Hood Multifoods Inc.
Grain Dept.
1040-167 Lombard Ave.
Winnipeg, Manitoba Canada R3B 0T4

Roderick, H. W.
Welsh Plant Breeding Station
Plas Gogerddan
Aberystwyth SY23 3EB
Dyfed, WALES

Roelfs, Alan P.
Cereal Rust Laboratory
University of Minnesota
St. Paul, MN 55108

Rogers, W. J.
Cytology Dept. W.P.B.S.
Plas Gogerddan Near Aberystwyth
SY23-3EB Wales
UNITED KINGDOM

Roland, Magnus
Weibullsholm Pl Breed Inst.
Bjertorp
535 00 Kvanum,
SWEDEN

Roozeboom, Kraig
Department of Agronomy
Throckmorton Hall
Kansas State University
Manhattan, KS 66506

Roskens A. Bruce
The Quaker Oats Company
P.O. Box 9001
Chicago, IL 60654 - 9001

Rossnagel, Dr. Brian
Crop Development Centre
Univ. of Saskatchewan
Saskatoon, Sask. Canada
S7N 0W0

Rowoth, Paul
107 Curtis Hall
University of Missouri
Columbia, MO 65211

Rubio, Hector
Apartado Postal 1204
Chihuahua, Chih.MEXICO

Saastamoinen, Marketta
Dept. of Plant Breeding
Agricultural Research Center
31600 Jokionen
FINLAND

Sadaranganey, Gobind T.
Robinhood Multifoods Inc
191 Attwell Drive
Rexdale, Ontario M9W 5Z2
Canada

Saidi, Seddik
Forage Program
BP 6570Rabat-Instituts Rabat
MOROCCO

Salmeron-Zamora, Dr. Jose Juan
APDO. Postal No. 554
CD. Cuauhtemoc, Chic. 31500
MEXICO

Sammons, David J.
Dept. of Agronomy
University of Maryland
College Park, MD 20742

Sato, Shinnosuke
Oat Breeding Lab
Kyushu National Agric.
Exp Sta Nishigoshi, Kumamoto
861-11, JAPAN

Saur, Laurent
I.N.R.A.
Station d Amelioration des plantes
B.P. 2935650 LE RHEU
FRANCE

Scanlan, Jack
National Oats Co.
1515 H Avenue N.E.
Cedar Rapids, Iowa 52402

Schaffer, Vernon A.
Department of Agronomy
Throckmorton Hall
Kansas State University
Manhattan, Kansas 66506

Schaller, L. A.
The Kusa Research Foundation
P.O. Box 761
Ojai, CA 93023

Schaller, Dr. C. W.
Agron/Range Sci. Dept.
University of California
Davis, CA 95616

Schefer, Mr. Roberto
Quaker - Virrey Del Pino 2458
1426 Buenos Aires
ARGENTINA

Schipper, Harm
Agronomy Department
Iowa State University
Ames, Iowa 50011

Schipper, Harm
Agronomy Department
Iowa State University
Ames, Iowa 50011

Schmidt, John W.
322 Keim Hall - East Campus
University of Nebraska
Lincoln, NE 68583

Schrickel, Donald J.
2502 E. Shaw Butte Dr.
Phoenix, AZ 85028

Schuler, Grace
127 Clinton Street
Boone, Iowa 50036

Schwein, Rick L.
P.O. BOX 86
Cochranz, WI 54622
608-248-2222

Sebesta, Josef
RICP-Plant Protection
Div. 161 06
Praha 6, Ruzyne 507
CZECHOSLOVAKIA

Section Serials
University Library
University of California
Davis, CA 95616-5292

Segal, Adrian
Tel Aviv University
Faculty of Life Sciences
Institute for Cereal Crops Impr.
Ramat Aviv, ISRAEL

Seguin, Len
Canadian Grain Commission
900 - 303 Main Street
Winnipeg, Manitoba Canada
R3C 3G8

Semple, Jayne T.
Nickerson S.A.
5, rue de l'Egalite
CHARTAINVILLERS 28130
MAINTENON FRANCE

Services Head
Library
Indian Agric. Research Inst.
(Pusa) Library
New Delhi, 110012, INDIA

Shah, Dr. M. H.
Imran Villa
Bagat Barzalla
Srinager Kashmir 190005
INDIA

Shands, Dr. H. L.
919 University Bay
Madison, WI 53705-2248

Shands, Henry L.
USDA, ARS, NPS
Rm 140, Bldg. 005 BARC-West
Beltsville, MD 20705

Shaner, G. E.
Botany & Pl. Pathology Dept.
Purdue University
W. Lafayette, IN 47907

Shugar, Leslie
W. G. Thompson & Sons Ltd.
R#1 Ailsa Craig
c/o Nairn Research Lab
Ontario Canada NOM 1AO

Sierra, Jose A.
Calle 22 Bis N 44A-64
Apartado Aereo 12244
Bogota - COLUMBIA
SOUTH AMERICA

Sij, Jr. Dr. John
Texas A&M Univ.
Agric Res Ctr - Beaumont
Rt 7, Box 999
Beaumont, TX 77713

Simmons, Steve
Dept. of Agron. & Pl. Genetics
University of Minnesota
St. Paul, MN 55108

Simons, Marr D.
18013 Willowbrook Drive
Sun City, AZ 85373

Skrdla, Ronald
Agronomy Department
Iowa State University
Ames, Iowa 50011

Slaughter, Leon H.
H. J. Patterson Hall
College Park, Maryland 20742

Slinkard, A. E.
Crop Science Dept.
University of Saskatchewan
Saskatoon, Sask.
Canada S7N 0W0

Smart, Geoffrey
Pacific Seeds Pty Ltd.
268 Anzac Avenue, P. O. Box 337
Toowoomba, Qld. 4350
AUSTRALIA

Smith, Harry J.
Quaker Oats Co. of Canada
Quaker Park
Peterborough, Ontario
Canada K3J 7B2

Smith, E. L.
Agronomy Dept.
Oklahoma State University
Stillwater, OK 74074

Smith, Gordon
Quaker Oats Limited
P O Box 24, Bridge Road
Southall, Middlesex UB24AG
ENGLAND

Smyth, W.
Speedicook Ltd., Scarva Road
Tandragee Co. Armagh BT62 2BY
IRELAND

Soldatov, Dr. Viktor N.
All. Union Inst. of Plant Industry
Leningrad, 44 Herzen str.
USSR

Somoza, Manuel
Juan Mata Ortiz No 303
C P 31700
Nuevo Casas Grandes Chih
MEXICO

Sorrells, Dr. M. E.
Plant Breeding Dept.
252 Emerson
Cornell University
Ithaca, NY 14853

Springer, Warren D.
Malt-O-Meal Company
701 W. 5th Street
PO Box 180
Northfield, MN 55057

Stankova, Ing. J.
Central Agricultural & Forestry
Library 120 56
Praha 2-Vinohrady, Slezska 7
CZECHOSLOVAKIA

Starling, Dr. T. M.
Dept. of Agronomy
Virginia Polytechnic Inst.
Blacksburg, VA 24061

Stevens, James B.
Dept. of Agronomy
Univ. of Wisconsin - Madison
1575 Linden Drive
Madison, WI 53706

Stoyanov, D.
Institute of Introduction & Plant
Genetic Resources
4122 Sadovo Near Polvdiv
BULGARIA

Stuthman, Dr. D. D.
Dept. of Agron. & Pl. Genetics
University of Minnesota
St. Paul, MN 55108
Sutherland, Susan

The Quaker Oats Company
P.O. Box 9001
Chicago, IL 60654 - 9001

Swierczewski, Mgr. Andrzej
Wielopole 1, skr.poczt.117
33-300 Nowy Sacz
POLAND

Tabata, Seiji
Agronomy Dept.
Hokkaido Nat Agr Exp Sta
Hitsujigaoka Toyohira Sapporo 004
JAPAN

Tajimi, Akitoshi
Hokkaido National Agric.Exp. Sta.
Hitsujigaoka Toyohira-Ku Sapporo
004
JAPAN

Takada, Hiroyuki
Agronomy Dept.
Hokkaido Nat. Agr. Exp. Sta.
Hitsujigaoka, Toyohira
Sapporo 004, JAPAN

Tan, Ayfer
Plant Genetic Resources Research
Inst. P.O. Box 9
Menemen, 1ZMIR 35661
TURKEY

Taylor, H. F.
Long Ashton Research Division
Weed Research Division
Yarnton, Oxford OX5 1PF
UNITED KINGDOM

Taylor, Michael
Nickerson Pflansenzucht (N.P.Z.)
West Ende 8
3160 ArpkeLehrte, WEST
GERMANY

Tempest, Geoff R.
Cereal Foods Ltd.
P. O. Box 951
Auckland.1
NEW ZEALAND

Thomas, Hugh
Welsh Plant Breeding Station
Plas Gogerddan
Aberystwyth, DYFED
UNITED KINGDOM

Thomas, Dr. Percy
Agriculture Canada
195 Dafoe Road
Winnipeg, Manitoba
Canada R3T 2M9

Thomason, Ronald C.
Division of Agriculture
Box 998 W. T. Station
Canyon, TX 79016

Tomaso, Juan Carlos
I.N.T.A. Estacion Experimental
Agro Pecuaria 8187 Bordenave
Prov. De Buenos Aires,
ARGENTINA

Tonelli, Walter
Corso Statuto 2612084
Mondovi (Cuneo) ITALY

Trombetta, Mr. Romulo
Elaborador Argentina de Cereales
S.A Cereal Plant Barracas 38
(1275) Buenos Aires
ARGENTINA

Trottet, Maxime
I.N.R.A.
Station d Amelioration des plantes
B.P. 29
35650 LE RHEU, FRANCE

Truter, J.
Winter Rainfall Region
Private Bag
Elsenburg 7607
REPUBLIC OF SOUTH AFRICA

Tsunewaki, Koichpiro
Faculty of Agriculture
Kyoto University
Kitashira Kawa, Sakyo-ku
Kyoto 606 JAPAN

Turner, J. C.
Quaker Oats Ltd.
P. O. Box 24
Bridge Rd., Southall
Middlesex, ENGLAND

Tuten, Dr. Cetin
Aegean Regional Agric. Inst.
(ARARI)
P. O. Box 9
Menemen/IZMIR TURKEY

Ueyama, Yasufumi
Kyushu National Agric.
Experiment Station Grassland Div.
Nishigoshi, Kumamoto 861-11
JAPAN

University, Cornell
Aquisitions Division
Albert R. Mann Library
Ithaca, NY 14853-4301

Urquhart, Mr. G.
Twyford Seeds Ltd.
Plant Breeding Dept.
Scott's Farm, King's Sutton
Danbury, Oxon 0X16 9BQ UK

Valentine, Dr. J.
University College of Wales
Welsh Plant Breeding Station
Plas Gogerddan Near Aberystwyth
Dyfed, SY 23 3FB, UK

Van Der May, J.
Small Grain Centre
Private Bag X29
Bethlehem 9700
REPUBLIC OF SOUTH AFRICA

Van Niekeric, Dr. H. A.
Private Bag X29
Bethlehem
REPUBLIC OF SOUTH AFRICA

Vander Vliet, W. H.
Caixa Postal 1169 Carambei
EP8417 Parana
BRASIL

Vanselow, M.
Institut fur Angewandte Genet.
Universitat Hannover
Hannover GERMANY

Vasquez, Matilde Martinez
Comumidad de Madrid
Servicio Investigacion
Agraria-Ap.127 Alcala de Henares
(MADRID) SPAIN

Vergara, L. M.
Library and Documentation Center
International Rice Research
Institute, P.O. Box 933
Manila, Philippines

Verma, J. S.
Dept. of Plant Breeding
G. B. Pant University of Agric. &
Tech. Pantnagar, Nainital-263 145
INDIA 26314-5

Vermeulen, P., Dir.,
Bakint Tech. & Quality Assurance
Robin Hood Multifoods Inc.
191 Attwell Drive Unit #4
Rexdale Ontario M9W 5Z2

Visser, P. A.
Kleingraansubsentrum
Winterreenstreek
Privaatsak Elsenburg 7607
REPUBLIC OF SOUTH AFRICA

Vogel, Ric
Fruen Milling Co.
301 Thomas Ave.
Minneapolis, MN 55406

Wahl, I.
Dept. of Botany
Tel Aviv University
Tel Aviv Ramat-Aviv
69978 ISRAEL

Walter, Harold
Muhlenwerke am Hafen
d-2200 Elmshorn
GERMANY

Weaver, Dr. S. H.
The Quaker Oats Company
617 W. Main St.
Barrington, IL 60010

Webster, Dr. J. A.
USDA-ARS
Plant Science Res. Lab.
1301 N. Western St.
Stillwater, OK 74075

Webster, Dr. Fran
The Quaker Oats Company
617 West Main Street
Barrington, IL 60010

Weibull, Dr. Jens
W Weibull AB, Box 520
S-261 24 LANDSKRONA
SWEDEN

Welch, R. W.
Biology Department 2D20,
Univ. of Ulster Jordanstown,
Newtownabbey, BT370QB
UNITED KINGDOM

Wesenberg, Dr. D. M.
National Small Grains
Germ. Res. Facil.
P O Box 307
Aberdeen, ID 83210

West, Trevor
Weed Research Dept.
Long Ashton Research Station
Long Ashton, Bristol
BS 18 9 AF ENGLAND

Western, D. E.
3365 Spring Mill Circle
Sarasota, FL 34239

White, Dr. Pamela
Room 3367, Dairy Industry Bldg.
Iowa State University
Ames, Iowa 50011-1060

Wilcoxson, Dr. Roy
Dept. of Plant Pathology
495 Borlaug Hall
University of Minnesota
St. Paul, MN 55108

Williams, Curtis
Hartz Seed Co.
P. O. Box 946
Stuttgart, AR 72160

Williams, H. T.
A & R Scott
Cupar
Fife SCOTLAND

Wilson, David
Crop Improvement Division
Welsh Plant Breeding Stn
Plas Gogerddan, Aberystwyth
DYFED SY23 3EB, UK

Wise, Dr. Roger
Department of Plant Pathology
Iowa State University
Ames, Iowa 50011

Woodhull, Ralph
617 W. Main St.
Barrington, IL 60010

Worrall, David
P. O. Box 1658
Texas Ag. Experiment Station
Vernon, TX 76384

Worrell, Dr. W. D.
Texas A&M Univ.
Agric. Res Ctr
P. O. Box 1658
Vernon, TX 76384

Wouda, Ing. K. P.
Semundo B.V.
Postbus 2
9970 AA ULRUM
HOLLAND

Wright, G. M.
49 Acarcia Avenue
Christchurch 8004 NEW ZEALAND

Wright, D. S. C.
Crop Research Div., Cereal Section
D S I R Private Bag
Christchurch, NEW ZEALAND

Wright, G. M.
33 Harakeke St.
Christchurch, NEW ZEALAND

Wu, Victor
USDA
Northern Regional Research Center
1815 N. University
Peoria, IL 61604

Yamaguchi, Hirofumi
Snow Brand Seed Co. Ltd.
Chiba Research Station
631 Naganumahara-cho
Chiba City, Chiba Pref. 281 JAPAN

Yarrow, Gary L.
The Quaker Oats Company
John Stuart Res. Center
617 West Main St.
Barrington, IL 60010

Yoder, Harvey
District Agriculturist
Box 389
Lac La Biche, Alberta Canada
T0A 2C0

Young, Lee R.
617 West Main St.
Barrington, IL 60010

Youngs, Dr. V. L.
Dept. of Cereal Technology
North Dakota State University
Fargo, ND 58105

Zadoo, Dr. S. N.
Div. of Plant Improvement
Indian Grassland & Fodder Res. Inst.
Jhansi 284003 INDIA

Zeller, F. J.
Technische Universitat Munchen
805 Freising-Weihenstephan
GERMANY

Zuloaga-Albarran, Dr. Alberto
Apartado Postal No. 10
56230 Chapingo, MEXICO