Canada-Saskatchewan Irrigation Diversification Centre

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Annual Review

April 1, 1999 to March 31, 2000

- Contents -

This report and other SIDC publications are available at our internet address:
http://www.agr.ca/pfra/sidcgene.htm

Introduction

Manager's Report

It is my pleasure to present the annual progress report of the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC). This report summarizes the wide range of activities conducted, funded or facilitated by the Centre in 1999. I would like to extend special thanks to our Executive Management Committee (EMC). Their input, direction and support have been key to the successful operation of the Centre.

CSIDC is a federal, provincial and industry partnership. Industry is represented by the Saskatchewan Irrigation Projects Association (SIPA) and the Irrigation Crop Diversification Corporation (ICDC), federal government by Agriculture & Agri-Food Canada, PFRA, and the provincial government by Saskatchewan Water Corporation. Representatives from each group are members of the EMC.

Executive Management Committee (EMC)

Don Fox, SIPA
John Linsley, ICDC
Gerry Luciuk, PFRA
Carl Siemens, ICDC
Dale Sigurdson, Sask Water
Laurie Tollefson, CSIDC

The past year witnessed many positive happenings at the Centre. This included the development of a strategic plan and from that, a business plan. This plan will be utilized to help define the roles of the partners and set priorities for irrigated research, demonstration and extension in the next five year period.

1999 was a landmark year for CSIDC. It marked the 50th year of operation of this facility serving our irrigation clientele. It has been rewarding to see the evolution of this Centre from its origins in 1949 as the Pre-Development Farm to today's Canada-Saskatchewan Irrigation Diversification Centre, a "World Class" facility dedicated to sustainable irrigated crop production. A special section on the history of the facility has been included in this report. To commemorate the anniversary, a staff reunion was held in conjunction with our annual July field day. It was truly a memorable occasion with a large turn out of past and present employees along with a large field day crowd. All were eager to view the work being done today at CSIDC and to reflect and reminisce on the many changes.

There continues to be a need to diversify and adopt irrigated cropping practices that encourage higher valued crop production with value-added potential. Depressed commodity prices have accentuated this need for new alternatives. Increasing numbers at our annual field day and commodity tours, and requests for information all substantiate this need for information on diversification opportunities.

Adequate funding to continue this work is an ongoing concern at CSIDC. Traditionally, the Centre has relied on federal and provincial A-base dollars, along with agreement funding to facilitate the program. The Partnership Agreement on Water-Based Economic Development (PAWBED) was a good example of agreement funding being utilized to intensify programming. The research and demonstration portion of this agreement was managed by CSIDC. Benefit/cost analysis demonstrated returns ranging from 3/1 for cereal research to 12/1 for potatoes. The Agri-Food Innovation Fund (AFIF) is a more recent industry-driven agreement which has provided funding to the agriculture and irrigation sectors in Saskatchewan. CSIDC has utilized funding from this program to support industry-driven initiatives in vegetable, potato, herb and spice, pulse, and turf grass seed production. Many opportunities for industry have and will continue to result from this work.

CSIDC staff continue to be involved nationally and internationally through membership and participation on national and international committees, and through direct involvement in projects such as CIDA-sponsored projects in Egypt and China. CSIDC was directly involved, for example, in training a Chinese agronomist from the Hebei project in China regarding irrigation water conservation technology. This type of interaction keeps staff current and allows networking and new ideas to be continually brought forward to our Centre.

We look forward to serving our clients in the new millennium.

Objectives

1. Identify higher value cropping opportunities through market research to help target research and demonstration programs.
2. Conduct, fund and provide support for irrigated research and demonstration to meet the needs of irrigation producers and industry in the province.
3. Develop, refine, and test methods of diversifying and intensifying irrigated crop production in co-operation with outside research agencies.
4. Demonstrate sustainable irrigated crop production practices at CSIDC.
5. Promote and extend sustainable irrigated crop production methods.
6. Evaluate the environmental sustainability of irrigation, and evaluate the impact of irrigation on natural and physical resources.
7. Promote a Western Canadian approach to irrigation sustainability by interacting with staff from similar institutions and industry across Western Canada, and by transferring this technology to the industry. This will increase levels of co-operation in marketing, research and demonstration in support of diversification and value added processing.

Staff

Manager:	L. Tollefson	ICDC Agrologists:	J. Linsley
Administration:	M. Martinson		L. Bohrson
Secretarial:	J. Clark		I. Bristow
Casual Clerical:	D. Greig		K. Olfert
Market Analyst:	H. Clark	Field Operations:	B. Vestre
Field Crops Agronomist:	L. Townley-Smith	Irrigation:	D. David
Irrigation Sustainability:	T. Hogg	Maintenance:	A. MacDonald
Technician	M. Pederson	Student Interns:	G. Kort
Specialty Crops Agronomist:	J. Wahab		N. Warwaruk
Technician	G. Larson		G. Saraurer
Technician	S. Avis	Technology Transfer:	J. Harrington

History

Commemorating the 50th anniversary...1949-1999[1]

This year, the Canada- Saskatchewan Irrigation Diversification Centre celebrated its 50th anniversary. The Centre has gone through four significant phases over this period, each one designed to further irrigation development and crop diversification in the province...

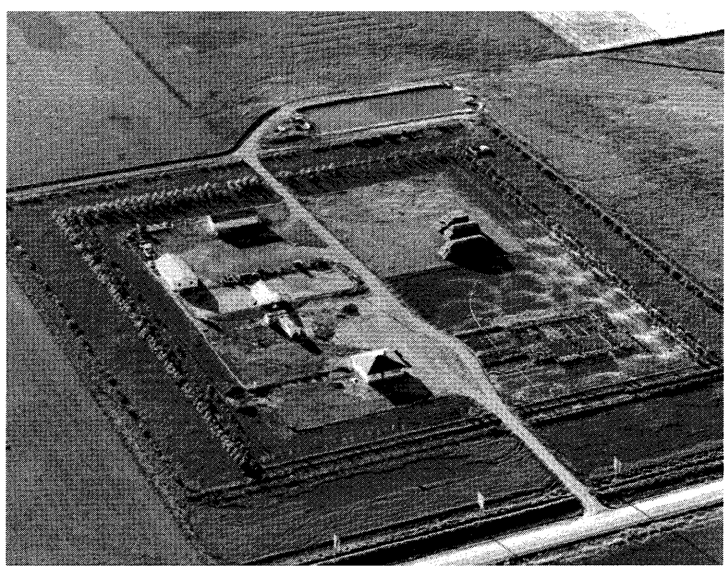
Pre-Development Farm, 1949 - 1967

"Before the dam"

During its first 18 years, the Centre was known as the Pre-Development Farm, a name derived from the fact the farm was established before the ***development*** of a dam across the South Saskatchewan River. The dream of a dam had been around since the days of the first settlers, and had been kept alive over the decades by southern Saskatchewan's semi-arid climate, its periodic droughts, and its growing population. On July 25, 1958, the dream became a reality when the federal and provincial governments signed an agreement to build a dam near Elbow, Saskatchewan. The project, known as the South Saskatchewan River Development project (SSRD), included building Canada's largest earth filled dam (Gardiner), the smaller Qu'Appelle Dam and creating a lake (Diefenbaker). It was a mammoth task that took seven years to complete. Canada provided 75 per cent of the overall cost and Saskatchewan 25 per cent, while the Prairie Farm Rehabilitation Administration (PFRA) provided project design and construction supervision. The project was officially opened in 1967.

Anticipating a dam would be built, Agriculture and Agri-Food Canada (AAFC) established the Pre-Development Farm at Outlook, Saskatchewan, in 1949 to introduce irrigation technology, including water application and the types of crops to grow, into the dryland farming area around Outlook.

PFRA was placed in charge of the farm, which was to be used for demonstration purposes only. Detailed studies of various crops under irrigation were carried out by AAFC's Research Branch on experimental plots adjacent to the farm. Water for both operations was pumped from the South Saskatchewan River.



Aerial view of the Pre-Development Farm site, 1952. The farm surrounds the yard site

[1]*Courtesy of PFRA Communicator, June 1999*

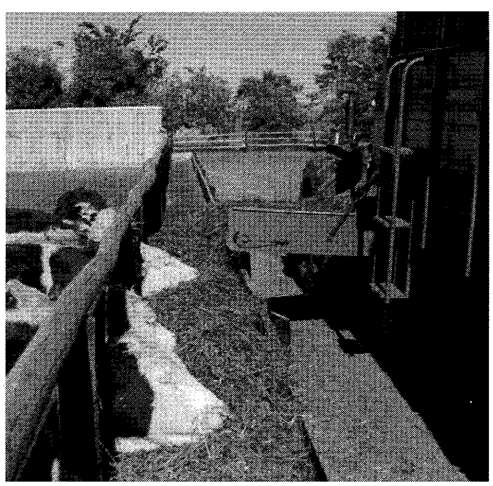
Bob Kohlert, co-ordinator of PFRA's regional operations, worked at the farm as a summer student (1962 & 1963) and as manager (1964-1967):

Flood Irrigation: Opening a sluice gate, 1962

"When I first arrived in 1962 as a summer student, the farm used mostly flood irrigation with some hand move sprinkler systems. The water supply was one of our biggest limitations. Water had to be pumped up from the South Saskatchewan River, which was about 286 feet below the farm. Lifting water that height limited our supply to only 3 cubic feet per second. Because the amount was small, we had to operate our irrigation system 24 hours a day over the summer.

The fields were 10-12 acres in size, and whether using flood or sprinkler irrigation, getting water on the fields required a lot of hand labour moving pipes and opening the irrigation ditches. Our work week was eight hours a day from Monday to Friday and a half day on Saturday. Moving pipe at night wasn't counted as part of the work day.

One of the exciting parts of our work was searching out new and innovative equipment that could be bought and demonstrated at the farm. In the early 60s, for example, we brought in some of the first mechanized haying equipment---- a conditioner to cut hay and a stack liner to load the bales. We introduced border dike land levelling and side move wheel irrigation systems to improve water distribution and reduce labour requirements.



Feeding steers using a mechanical grazing system, 1962

Basically, it was an innovative place where people could come and see and try new things. We tried many different things; not all succeeded. But, better we crash them on a small scale than a farmer take something on and fail.

The farm was often described as an oasis, and in many years it was like a green postage stamp on a brown landscape. It was a place that local people saw as their own. They would bring visitors for tours and, on Sundays, hold family picnics on the grounds. At that time, the manager and the foreman lived on the farm, and it was open seven days a week.

When the dam was built and irrigation became a reality on farms, there was a need to examine the role of the facility. We decided to make the operation more scientific, and to broaden the range of crops we grew and the information we provided to the new and emerging irrigation industry that was growing up around the SSRD. To reflect these changes, we changed its name to the PFRA Demonstration Farm."

PFRA Demonstration Farm
1967-1986

"Broadening activities"

During this period, the farm continued to be an intermediate point between research and actual farm production, providing demonstrations and information on irrigation, drainage, special crops, fertilizers, weed and bug control, special equipment, and livestock production. Much of the work was carried out in co-operation with the University of Saskatchewan and various provincial government departments.

It was also a period, however, when staff began to broaden the farm's activities to help it play a larger role in the irrigation sector. Hugh Cook, Head, Pasture Planning Section, Regina, was the farm's manager from 1975 to 1979 and recalled some of these steps:

Top: Combining grain corn, 1981

Right: Large scale hay demo, 1986

Bottom:Carrot harvest, 1971

"We initiated more irrigation scheduling trials, demonstrated different types of irrigation techniques and irrigation sprinklers, and increased the variety of crops we were demonstrating. We also introduced a management system that would track a project from start to finish. We would search out where seed could be purchased, then learn how to grow it under irrigation, and finally, where to sell it. It was a way of learning what the costs were going to be for a crop and whether or not it was economically feasible to grow under farming conditions. To help ensure we were on the right track, we actively sought advice from farmers, industry and the university community."

The following list of crops from the farm's 1973 annual report illustrates how much crop production had diversified from the early days of primarily cereals and forages: confection and oilseed sunflowers, barley, grain corn, pinto and navy beans, forage, irrigated pasture, buckwheat, triticale, navy field beans, great northern beans, trapper field peas.

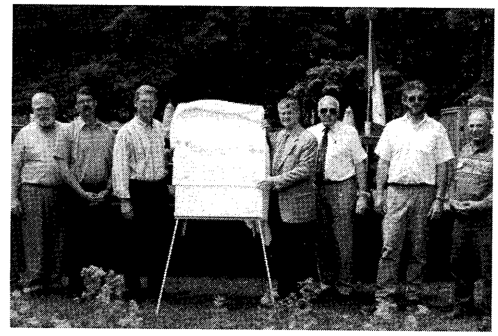
Livestock also continued to be an important part of the farm's work during this period. Tests were done with irrigated pasture, intensive grazing, and various feeds, including corn silage and cull potatoes.

Despite the increase in activities, it would take a major initiative by the federal and provincial governments before the role or mandate of the farm would significantly change.

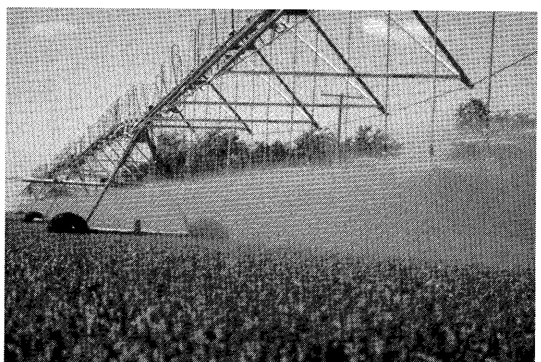
Saskatchewan Irrigation Development Centre 1986-1998

"A world class irrigation centre"

In 1986, Canada and Saskatchewan signed a Memorandum of Understanding (MOU) to jointly operate the Demonstration Farm and make it responsible for planning and co-ordinating all federal and provincial irrigation research and demonstration activities in the province. For manager Laurie Tollefson, it was the most important event in shaping the facility's development. "It was a commitment by the federal and provincial governments to make the farm a world class irrigation site," he recalled. "Through the agreement we totally upgraded our infrastructure and equipment, and expanded our mandate to cover applied research and demonstrations. It was a complete makeover of the farm."



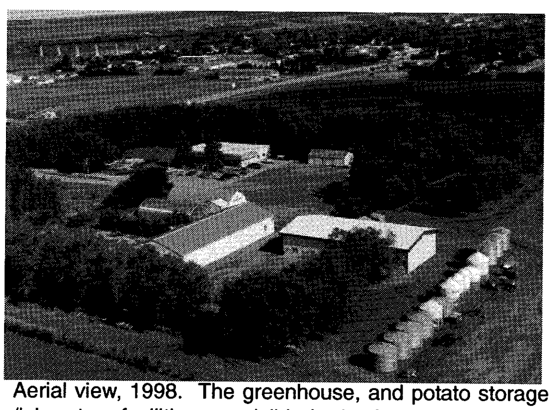
Signing of the new federal-provincial Memorandum of Understanding, 1998



Installation of an unique research linear in 1986 allowed irrigation scheduling studies on small plot trials

The upgrading included: removing all gravity water supply canals and installing a computer controlled, buried pressurized water supply line; building a new pumphouse; purchasing three electrically powered centre pivots and one linear irrigation system (especially designed for irrigation research work); improving the flood irrigation and surface drainage systems; adding a meteorological station; constructing a new office/laboratory complex and a workshop; and adding a line of specialized, small plot equipment to conduct replicated, small scale trials.

Under the MOU, the centre was given a mandate to place an emphasis on specialty and higher-value crop production. As a result, the cattle management program was discontinued. The farm's name was also changed, from Demonstration Farm to the Saskatchewan Irrigation Development Centre (SIDC).



Aerial view, 1998. The greenhouse, and potato storage /laboratory facilities are visible in the foreground

During this period, SIDC purchased an additional quarter section of land for its projects, managed an irrigated alfalfa demonstration project at the Rudy-Rosedale Community Pasture, and began working co-operatively on irrigated crop diversification activities with irrigation centres in Alberta and Manitoba through a tri-province MOU.

Another key to the centre's growth has been the availability of funding through various federal-provincial agreements, including the Canada Saskatchewan Irrigation Based Economic Development Agreement, the Partnership Agreement on Water Based Economic Development and the Canada-Saskatchewan Agri-Food Innovation Fund. "These agreements allowed us to increase our technical expertise," Laurie said, "and to fund industry driven research projects by off-centre organizations like the University of Saskatchewan and AAFC's Research Branch."

Canada-Saskatchewan Irrigation Diversification Centre 1998 to present

"The future"

The most recent change at the centre came in 1998 when the federal and provincial governments signed an agreement with irrigators in the province, represented by the Irrigation Crop Diversification Corporation (ICDC) and the Saskatchewan Irrigation Projects Association (SIPA), to jointly operate the centre. "The new, three-way partnership will help us develop an industry driven, co-ordinated irrigation research and development program," Tollefson explained. "There are a limited amount of dollars available to spend. With the agreement, government and industry will be able to co-ordinate their activities and maximize the benefits of these limited resources."


A professional facilitator leads the strategic planning discussion, 1998


Summer, 1999

On the program side, the centre is expanding its activities in higher-valued diversification options, including vegetables, potatoes and medicinal herbs. "We now work with a broad range of clients, from farmers with large-scale operations using centre pivots to market garden and small-scale producers using hand move and trickle irrigation systems. They are all part of our mandate of sustainable rural development through irrigated crop production." In addition, the centre has increased its research into the effects of irrigation and irrigated production on the enviroment.

To acommodate its new crop production, including the research and development needs of clients, the centre recently constructed a potato/vegetable storage, handling and processing facility and a greenhouse on the grounds. Funding for these facilities was provided through the Canada-Saskatchewan Agri-Food Innovation Fund.

International work is a relatively new ingredient at the centre. Staff expertise, for example, is being used on international projects funded by CIDA. Tollefson believes the reason for the interest is that the centre's expertise and state of the art technology have made it a well-known Canadian institution specializing in irrigation. A look at the centre's visitor list confirms Laurie's observation. In 1998, for example, tour visitors came from Holland, Britain, Japan, Brazil, Philippines, Chile, China, Australia, Egypt, and Russia.

A strategic plan was developed with its clients after the signing of the latest MOU, and an updated business plan is in the works. He believes the centre's future will depend on its ability to meets the needs of its clients.


International tour groups are regular visitors to the Centre

Programs

Specialty/Horticultural Crops

A specialty crops development program was initiated at SIDC in 1987. This program involves the evaluation of specialty crop production under irrigated conditions with the intent of developing cropping alternatives suitable to irrigated conditions in Saskatchewan. It involves a broad range of varietal evaluation, irrigation and agronomic adaptation studies. A major effort has been made to identify the most promising market opportunities and to act accordingly. Examples of projects include: varietal and agronomic evaluation of dry bean, pea, lentil, faba bean, mint, coriander, fenugreek, medicinal herbs, etc.

In 1992, emphasis was placed on potato and vegetable crop production. This was in response to industry demand. The potato studies involve a wide range of agronomic research to produce high quality 'seed', 'processing' and 'table' potato. The tests include germplasm evaluation, fertility management, irrigation scheduling, plant population studies and harvest management. The vegetable work is designed to raise awareness of the opportunities that exist in the vegetable industry. This is accomplished by developing cost of production information suited for Saskatchewan and by demonstrating improved production techniques to increase yield and improve quality, thereby improving economic returns.

Field Crops (Cereals, Oilseeds and Forages)

Field crops (cereals, oilseeds and forages) are a major part of any irrigated rotation. In 1996, more than 90% of the irrigated acreage in Saskatchewan was planted to field crops. While desirable to introduce new and specialty crops, a priority must also be placed on improving the profitability of the more conventional field crops. This includes examining new and/or existing genetic material with improved disease and lodging tolerance suited to irrigated conditions or with novel quality traits which could service a niche market. Suitable varieties must be identified and tested for agronomic performance under irrigated conditions. Evaluation of agronomic factors which can lead to more efficient water use, increased production or lower input costs must also be determined.

Environmental Sustainability

This program was designed to evaluate the effect of irrigation on the environment. It was initiated in 1991 with funding from the Environmental Sustainability Initiative. It was intensified in 1993 as the irrigation sustainability program using funding from the Canada/Saskatchewan Agriculture Green Plan. More recently the National Soil and Water Conservation Program has provided resources to evaluate the environmental effects under intensively irrigated crop production.

Market Analysis

This program was initiated to identify and evaluate potential markets for irrigated crops and to determine opportunities for value-added processing with the goal of promoting economic security and rural development in the irrigated areas.

Technology Transfer

This activity ensures that information developed at CSIDC is made available to farmers, extension personnel, private industry and the general public. It includes the annual field day, tours, participation in extension meetings, and report writing.

Field Demonstrations

ICDC agrologists conduct field demonstrations of applied research developed at CSIDC and other institutions. The Crop Manager project examines crop management practices of dry bean and cereals. The Forage Manager project evaluates alfalfa management for southern Saskatchewan irrigators.

Activities

Presentations

CSIDC staff gave presentations at numerous meetings, conferences, and events. Among those were:

Agri-Food Innovation Fund Hub and Spoke Herb Research update, Outlook

Agri-Food Innovation Fund Horticulture Technology Update, Saskatoon

Agri-Food Innovation Fund Special Crops Pulse Research update, Saskatoon

Canadian Water Resources Association meeting, Winnipeg

Canadian Water Vision conference, Montreal

CANCID, "Beyond 2000" conference, Lethbridge

China Hebei Dryland Project report session, Outlook

Commission on the Environment Group meeting, Regina

CSIDC/ICDC/Sask Water program update, Outlook

CWRA Egypt presentation, Regina

Horticulture Industry Workshop, Saskatoon

International Commission on Irrigation and Drainage Congress, Grenada, Spain

PFRA Senior Management Committee, Irrigation Crop Diversification meeting, Regina

PFRA Today symposium, Regina

Saskatchewan Herb and Spice Association annual meeting, Saskatoon

Saskatchewan Irrigation Projects Association annual meeting, Swift Current

Soils and Crops Workshop, Saskatoon

Trickle Irrigation Workshop, Outlook

Vegetable Production Opportunities meeting, Outlook

Western Potato Council annual conference, Lethbridge

2000 Cash Crops meeting, Swift Current

SIDC Display

CSIDC presented a display at trade shows at the following events:

Crop Production Show, Saskatoon

Trade Fair, Lucky Lake

Saskatchewan Irrigation Projects annual meeting, Swift Current

Saskatchewan Herb and Spice Association annual meeting, Saskatoon

CSIDC Annual Field Day, Outlook

Tours

A large number of tours of the Centre and of the field programs are conducted each year at CSIDC. Noteworthy groups touring the Centre in 1999 included:

University of Guelph MBA students	April 29
Producer group tour of herb and vegetable program	May 12
SIAST students	May 20
PFRA Southern Alberta Service staff	May 26
Prospective *Echinacea* growers (6 tours)	June
PFRA Land Management and Diversification Service	June 9
Agriculture and Bioresource Engineering students	June16
Australian Commonwealth Scholars	June 21-23
Dawson Creek PFRA staff	July 9
PFRA Director General's tour	July 13
CSIDC Annual Field Day	July 16
Ethiopian Agriculture Ministry delegation	July 16
Blood Tribe delegation	July 21
CSIDC Annual Evening Tour	July 21
Flexicoil Australian Farm group (2 tours)	August
CSIDC Potato Field Day	August 13
Agriculture and Agri-Food Canada delegation	August 19
Auditor General's Office, Ottawa staff	August 20
Vegetable Wholesale Buyers	August 26
Flexicoil Australian Farm group (3 tours)	September
Alberta Agriculture agrologists	September 7
Outlook Elementary School students	September 9
North Korean Ministry of Agriculture delegation	September 13
Agriculture and Bioresource Engineering students	September 13
Newfoundland Provincial delegation	September 27
Hokkaido Agricultural Experimental Station staff, Japan	October 5
JiLin Province agrologists, China	November 3
Chinese Hebei Dryland Project trainees	November 10
Cavendish Farms, PEI, delegation	January 21
President, SaskWater tour	March 10

Additional tours and activities were held for private industry, for members of the media, and for numerous other producers, agriculture professionals, industry groups, association representatives, and visitors who stop in at CSIDC.

Committees

L. Tollefson

- Agriculture and Agri-Food Canada National Potato Research Network
- Agri-Food Innovation Fund Horticulture Committee, Federal Co-chair
- Praire Potato Council Storage and Marketing Committee, Chair
- Canadian Commission on Irrigation and Drainage (CANCID), Executive member
- International Commission on Irrigation and Drainage (ICID) Crops and Water Use subcommittee
- National Water Quality and Availability Management Project, Egypt, Headquarters Co-ordinator; Executive Committee member
- PFRA Senior Management Committee
- Partners for the Saskatchewan River Basin Technical Committee
- Prairie Crop Diversification Task Force
- Prairie Agricultural Landscapes Technical Committee
- Health of Our Rural Water Steering Committee
- Dept. of Agriculture and Bioresource Engineering, Research Associate
- Herbfest 2000 Organizing Committee
- Canadian Water Resources Association Technical Committee, 2000 Conference
- USCID "Irrigation and Drainage in the New Millenium" Organizing Committee
- ICID 18th Congress and 35th International Executive Council, Montreal 2000 Organizing Committee
- Saskatchewan Vegetable Strategy working group

T. Hogg

- Prairie Regional Recommendation Committee on Grains
- Saskatchewan Advisory Council of Grain Crops
- Environmental Management Strategy Planning Committee
- PFRA Pesticide Review Committee
- PFRA Universal Classification System Evaluation team
- Canadian Water Resources Association Conference Technical Program Committee

L. Townley-Smith

- Prairie Agricultural Landscapes Technical Committee

H. Clark

- PFRA Universal Classification System Evaluation team
- Agriculture and Agri-Food Canada Ethanol working group

J. Wahab

- Agriculture and Agri-Food Canada National Potato Research Network
- Saskatchewan Seed Potato Growers Associaton
- Western Potato Council
- Potato Association of America
- Saskatchewan Herb and Spice Association
- International Herb Conference and Herbfest 2000 Organizing Committee
- Soils and Crops 2000 Organizing Committee
- PFRA Pesticide Review Committee

B. Vestre

- Enviromental Management Strategy Planning Committee
- Joint Occupation Safety and Health Committee
- PFRA Pesticide Review Committee
- PFRA Safety Orientation Committee
- Herbfest 2000 Organizing Committee

M. Martinson

- Saturn Implementation Committee
- PFRA Communicator Newsletter working group
- Environmental Management Strategy Planning Committee

Publications

Anonymous. Commemorating the 50th anniversary of the Saskatchewan Irrigation Diversification Centre. PRFA Communicator:1-8.

H. Clark, and M. Stumborg. 2000. Opportunities for the Expansion of Ethanol Production in Western Canada. In: Soils and Crops Workshop 2000;February 24 - 25; Saskatoon, Sask. Saskatoon: University of Saskatchewan Extension Division.

[CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 1999. Agri-Food Innovation Fund Specialized Spoke Sites Annual Report. 173 pp.

[CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 1999. Canada-Saskatchewan Irrigation Diversification Centre Overview. 8pp.

[CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 1999. Saskatchewan Irrigation Diversification Centre Annual Review. Outlook, Sask: CSIDC. 183 pp.

L. Tollefson, T. Hogg, and K. Stonehouse. 1999. Low Energy Irrigation Technology in Saskatchewan. In: CANCID special session in conjunction with Alberta Irrigation Projects Association meetings; Sept. 30 - Oct. 1; Lethbridge.

L. Tollefson, D. Tomasiewicz, B. Patterson, and L. Townley-Smith (prepared by Burton et al. LRCS Land Resource Consulting Service). 1999. Potential water management options for mitigating greenhouse gas emissions from agriculture.

L. Tollefson and B. Wettlaufer. 2000. National Water Quality & Availability Management Project. In: PFRA Technical Forum; April 20 - 23; Regina.

L. Townley-Smith, J. Wahab, T. Hogg, I. Bristow, and J. Harrington. 2000. Crop Varieties for Irrigation. Outlook, Sask: Canada-Saskatchewan Irrigation Diversification Centre. 16 pp.

J. Wahab. Field research in commercially important herbs. 2000. In: Soils and Crops Workshop 2000; February 24 - 25; Saskatoon, Sask. Saskatoon: University of Saskatchewan Extension Division.

J. Wahab and G. Larson. 2000. Field studies in commercially important herb crops. In: Saskatchewan Herb and Spice Association Annual Meeting; January 14; Saskatoon, Sask.

J. Wahab and G. Larson. 1999. Field studies of important herb crops. In: Richter's Herb Conference; October 21-23; Goodwood, Ontario.

J. Wahab and D. Waterer. 2000. Management practices for high quality processing potato production in Saskatchewan. In: Horticulture Industry Workshop: AFIF Project Summaries; March 6; Saskatoon, Sask.

J. Wahab. 1999. New initiatives in potato agronomy at the Canada-Saskatchewan Irrigation Diversification Centre. Agriculture & Agri-food Canada, Potato Network Meeting; Saskatoon, Sask.

J. Wahab, D. Waterer, and T. Hogg. 1999. Optimizing fertility levels and plant populations for potatoes grown under short growing seasons (abstract). In: Potato Association of America Annual Conference; July 31 to August 4; Somerset, New Jersey, U.S.A.

Factsheets

The following factsheets are available from the CSIDC. Please contact the Centre for copies.

***Cereals*:**
- Early Seeding of Irrigated Cereals
- Decision Guide for Foliar Disease Control in Irrigated Wheat
- Late Nitrogen to Increase Protein in Durum

Forages:
- Kentucky Bluegrass Establishment for Seed Production
- Effect of Cutting Height on Alfalfa Yield and Quality
- Irrigated Timothy Trials at CSIDC
- Alfalfa Establishment under Irrigated Conditions

Herbs and Spices:
- Herbs, Spices and Essential Oils Research & Demonstration
- Annual Caraway Trials at CSIDC
- Coriander Trials at CSIDC
- Dill Seed Trials at CSIDC
- Irrigated Scotch Spearmint Production in Saskatchewan

Marketing:
- Vegetable Price Comparison
- Ginseng Production and Marketing on the Prairies
- Ethanol Industry Set for Recovery

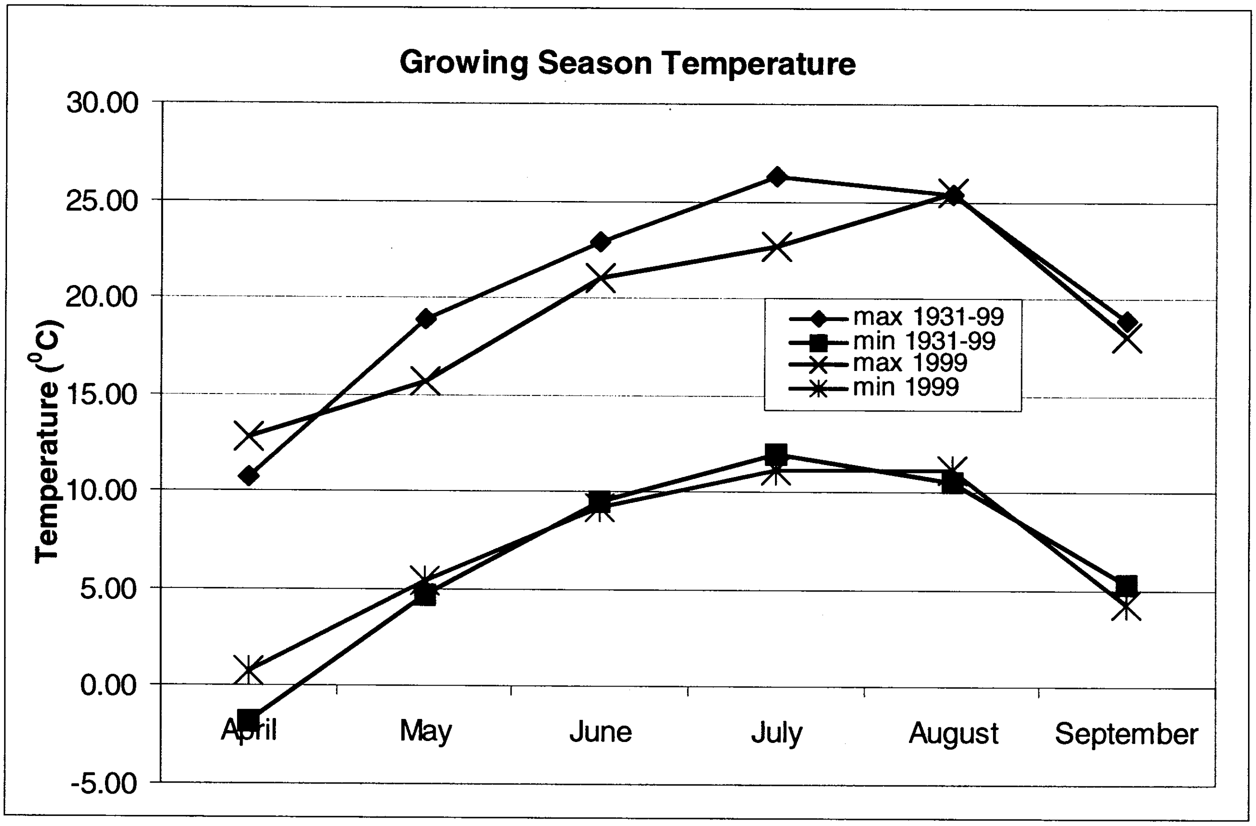
Oilseeds:
- Date of Seeding, Seed Rate, and Row Spacing of Irrigated Flax
- Seeding Rate and Row Spacing for Irrigated Canola
- Crop Management for Sclerotinia Control in Canola

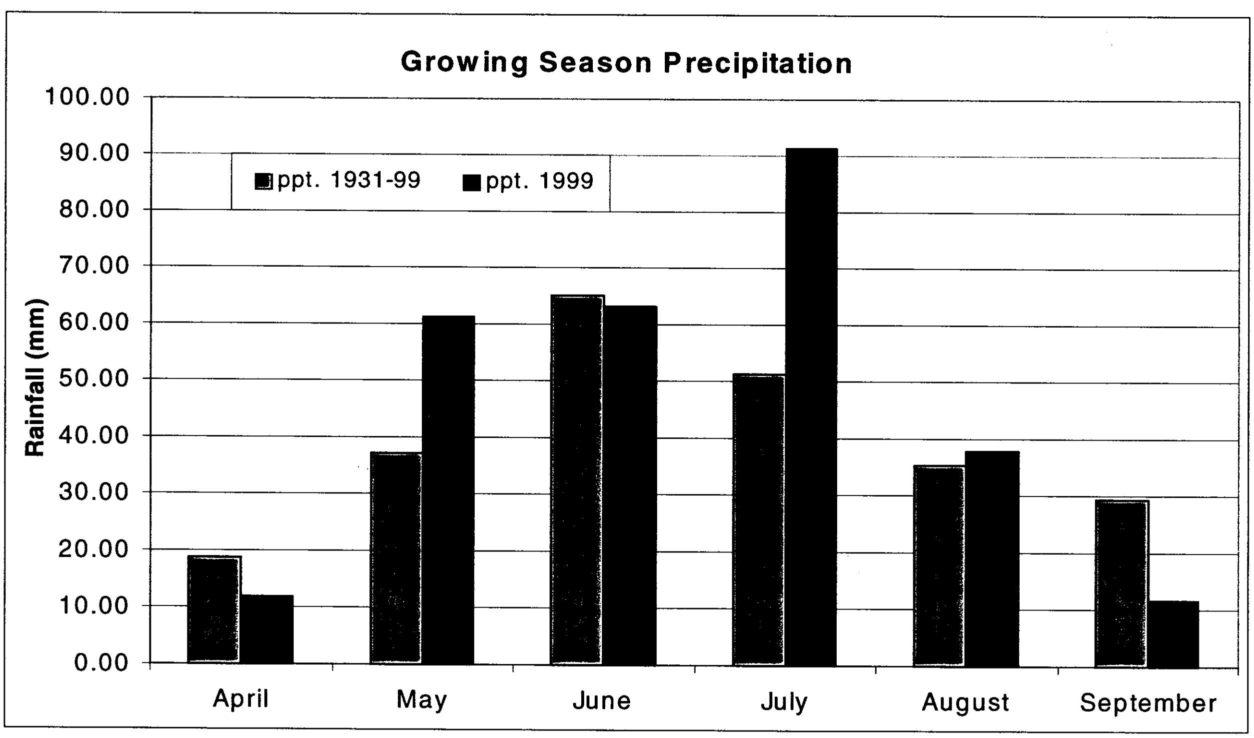
Pulse Crops:
- Dry Bean Production under Irrigation in Saskatchewan
- Intercropping Pea with Oilseeds under Irrigation
- Management of Field Pea under Irrigation
- Faba Bean Trials at CSIDC
- Management of Irrigated Lentil
- Irrigated Chickpea Trials at CSIDC

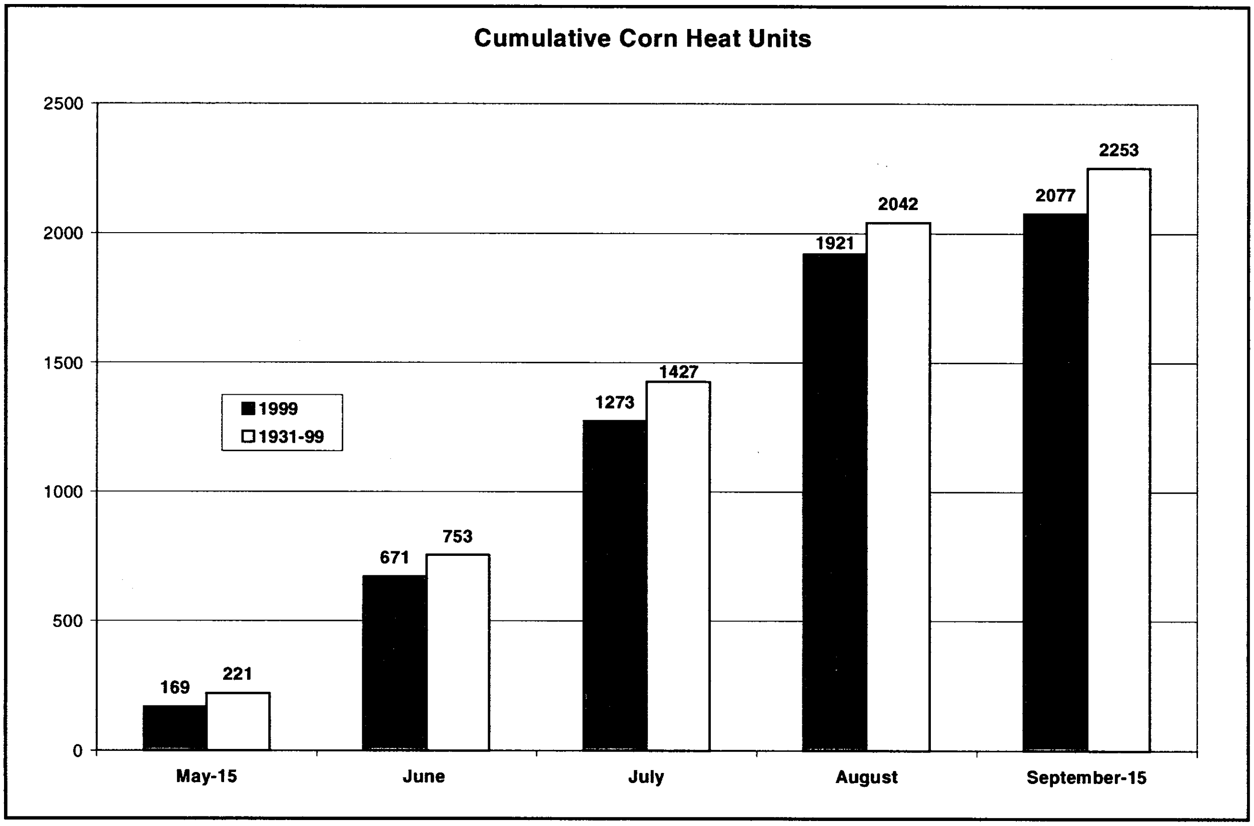
Soils and Fertilizers:
- Reclamation of a Saline Field using Subsurface Drains
- Rate and Placement Effects of P and K Fertilizer on Peas
- Fertility Management of Irrigated Alfalfa
- Canola Fertilization Trials at CSIDC
- Hog Effluent Research and Demonstration

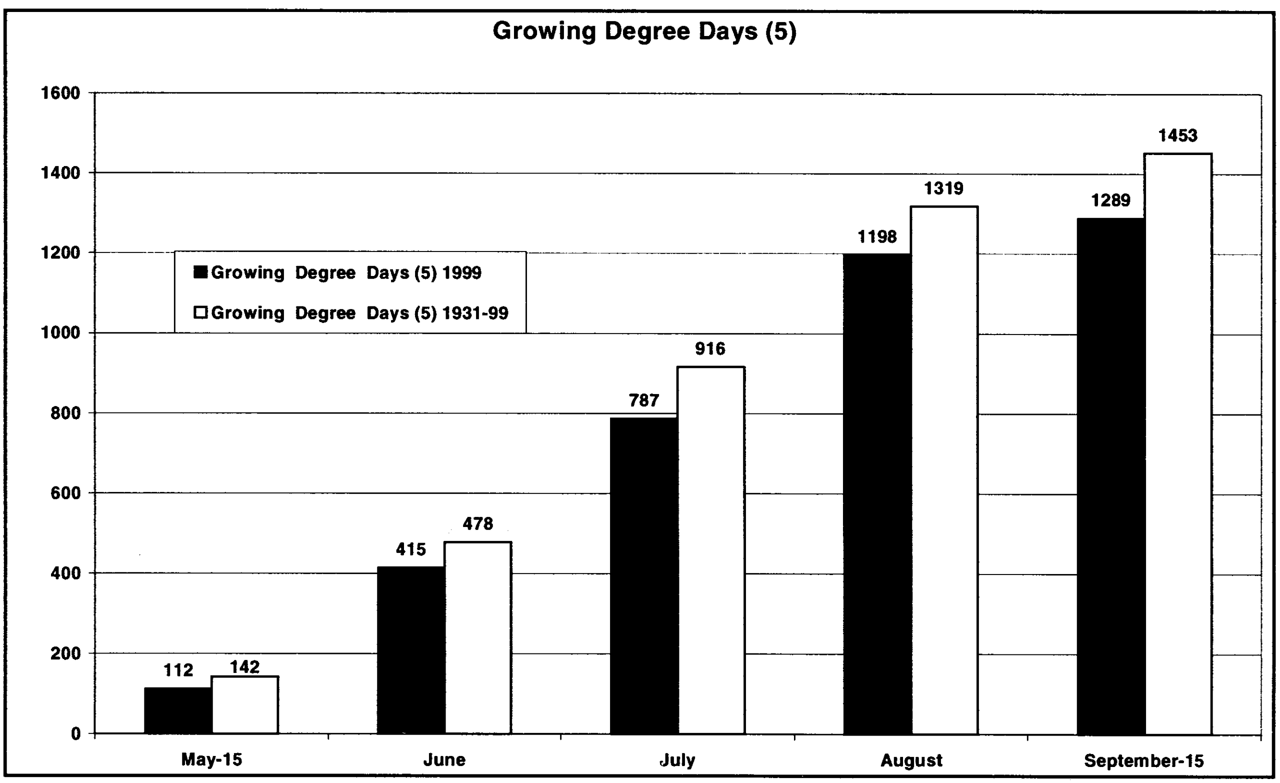
Other:
- Crop Varieties for Irrigation
- Overview of CSIDC
- Northern Vigor™ in Seed Potato
- Xeriscape Demonstration Project at CSIDC
- Plastic Mulches for Commercial Vegetable Production
- Market Outlooks for: Cereals; Oilseeds; Pulse Crops; Forages and Forage Seeds

1999 Weather Summary





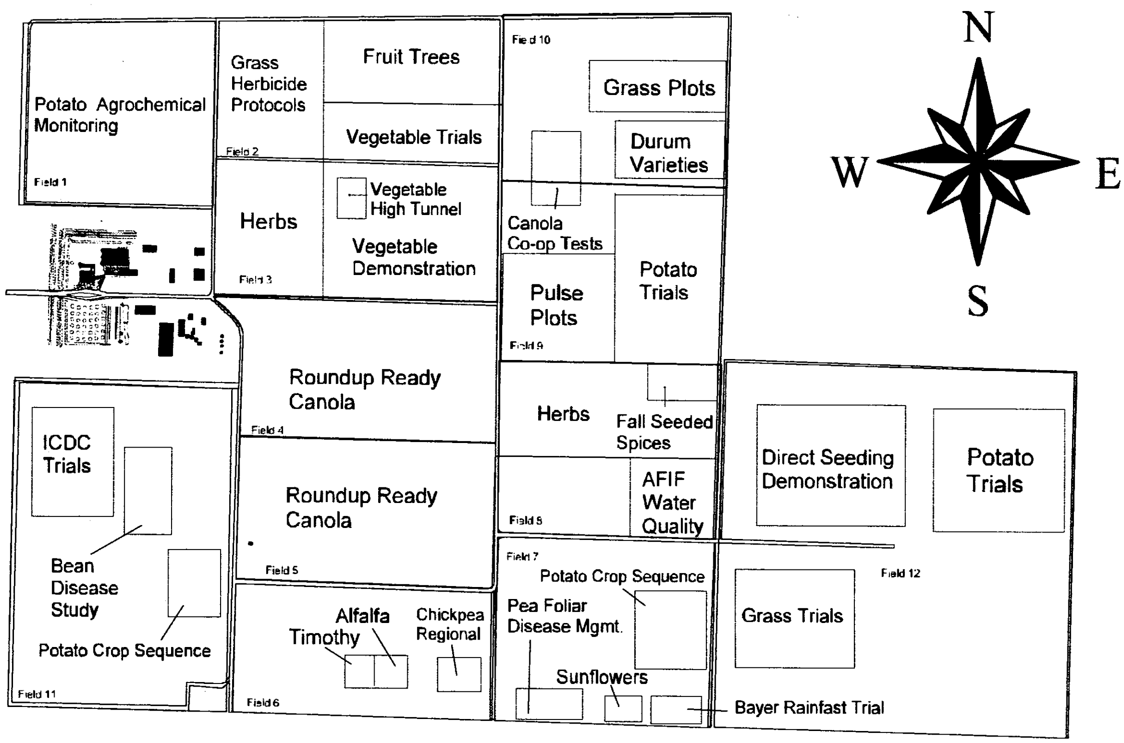

Cumulative Corn Heat Units
2500
2000
1500
1000
500
0
1999
1931-99
169
221
671
753
1273
1427
1921
2042
2077
2253
May-15
June
July
August
September-15


Growing Degree Days (5)
1600
1400
1200
1000
800
600
400
200
0
Growing Degree Days (5) 1999
Growing Degree Days (5) 1931-99
112
142
415
478
787
916
1198
1319
1289
1453
May-15
June
July
August
September-15

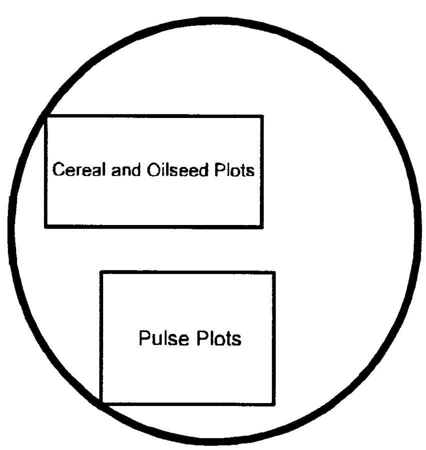
1999 Irrigation Data

Field	Crop	Irrigation (mm)					Total irrigation	
		May	June	July	Aug.	Sept.	mm	inches
CSIDC								
1	Potato	0	0	50	25	0	75	3.0
4	Canola	0	15	25	0	0	40	1.6
5	Canola	0	15	25	0	0	40	1.6
6	Chickpea	0	0	0	0	0	0	0
6	Soft Wheat	0	0	0	50	0	50	2.0
7	Potato	0	0	25	50	0	75	3.0
7	Field Pea	0	0	40	25	2	65	2.6
7	Soft Wheat	0	0	28	25	0	53	2.1
7	Crop sequence study	0	0	40	25	0	65	2.6
7	Sunflower	0	0	40	25	0	65	2.6
8	Herbicide water quality	0	0	25	0	0	25	1.0
8	Herbs and Spices	0	0	25	0	0	25	1.0
8	Potato	0	15	50	75	0	140	5.5
8	Lentil	0	0	0	0	0	0	0
8	Dry Bean	0	0	50	25	0	75	3.0
8	Faba Bean	0	15	50	25	0	90	3.5
8	Field Pea	0	15	50	25	0	90	3.5
9	Canola	0	15	15	50	0	80	3.2
9	Potato	0	15	50	75	0	140	5.5
9	Durum Wheat	0	15	15	25	0	55	2.2
10	Forages	0	15	15	50	25	105	4.2
10	Canola	0	15	15	50	0	80	3.2
10	Spearmint	0	15	15	50	25	105	4.2
11	North	0	15	16	25	0	56	2.2
11	South	0	0	16	25	0	41	1.6
12	Potato	0	15	50	75	0	140	5.5
12	Soft Wheat	0	15	25	0	0	40	1.6
12	Direct seed demo	0	15	25	25	0	65	2.6
12	Forages	0	15	25	0	0	40	1.6
Off-station Site								
	Northwest	0	15	45	30	0	90	3.5
	Northeast	0	15	45	30	0	90	3.5
	Southwest	0	25	45	45	0	115	4.5
	Southeast	0	25	70	30	0	125	5.0

SIDC MAIN SITE (SW15-29-08-W3)



SIDC OFF-STATION SITE (NW12-29-08-W3)



Cereals Program

Variety Evaluations

Cereals Program

Variety Evaluations

Western Canada High Yield Wheat Co-operative Test

L. Townley-Smith[1], I. Bristow[2]

Progress: *Ongoing*

Objective: *To evaluate potential new Canada Prairie Spring wheat varieties under irrigated conditions in western Canada.*

The High Yield wheat co-operative test was sown May 20 in 1.5 m x 4.0 m (5 ft x 13 ft) plots. 100 kg/ha N (90 lb N/ac) as 46-0-0, and 50 kg/ha P_2O_5 (45 lb P_2O_5 /ac) as 11-52-0 were side-banded at seeding. The plots were harvested September 15. The entire plot was harvested for yield measurements. Results of the test are shown in Table 1. Several lines combine high yield with good lodging resistance and short stature.

Western Canada Soft White Spring Wheat Co-operative Test

L. Townley-Smith[1], I. Bristow[2]

The Soft White Spring wheat co-operative test was sown May 20 in 1.5 m x 4.0 m (5 ft x 13 ft) plots. 100 kg/ha N (90 lb N/ac) as 46-0-0, and 50 kg/ha P_2O_5 (45 lb P_2O_5 /ac) as 11-52-0 were side-banded at seeding. The plots were harvested September 15. The entire plot was harvested for yield measurement. Results for the test are shown in Table 2.

[1] *CSIDC, Outlook*
[2] *ICDC, Outlook*

Table 1. Yield and agronomic data for the irrigated High Yield Wheat co-operative test, Outlook.

Line	Yield kg/ha	Yield bu/ac	Height (cm)	Lodging rating[1]
BW661	5201	76.9	82	1
HY395	4835	71.5	70	1
HY413	5018	74.0	71	1
HY417	4115	60.8	75	1
HY446	4783	70.8	70	1
HY448	3855	60.0	72	1
HY449	4998	73.9	77	1
HY455	4422	65.4	71	1
HY456	3465	51.2	60	1
HY457	5104	75.5	71	1
HY458	4645	68.7	70	1
HY459	5421	80.2	76	1
HY460	4739	70.1	72	1.5
HY523	4504	66.6	70	1
HY525	4008	59.3	67	1.5
HY527	4400	65.0	74	1
HY639	4966	73.4	76	1.5
HY643	5793	85.6	77	1.5
HY644	4845	71.6	71	1
HY647	5549	82.0	81	1
HY648	5872	86.8	76	1.5
HY649	5573	82.4	69	1
HY650	3744	55.4	68	1
HY651	4913	72.6	72	1
HY961	4953	73.2	64	1
HY962	4442	65.7	67	1
HY964	4268	63.1	74	1
HY965	4070	60.2	69	1
Mean	4712	69.8		

[1]1 = good, 9 = poor

Table 2. Yield and agronomic data for the irrigated Soft White Spring Wheat co-operative test, Outlook.

Line	Yield kg/ha	Yield bu/ac	Height (cm)	Lodging rating[1]
96B-157	3097	45.8	62	1
96B-37	4003	59.2	65	1
96DH-812	3944	58.3	66	1
96PR-329	3427	50.7	67	1
97DH-614	3528	52.2	64	1
98B-119	3769	55.7	66	1
98B-124	3707	54.8	65	1
98B-129	2956	43.7	63	1
98B-138	3824	56.5	68	1
98B-142	3677	54.4	63	1
98B-143	3737	55.2	64	1
98B-172	3490	51.6	65	1
98B-189	3368	49.8	63	1
98B-190	3074	45.4	63	1
98B-194	3480	51.5	68	1
98B-196	3517	52.0	64	1
98B-203	4219	62.4	63	1
98B-204	3708	54.8	63	1
98B-208	4039	59.7	66	1
98B-35	2798	41.4	62	1
98B-54	3823	56.5	62	1
98B-76	3451	51.0	65	1
98B-80	3203	47.4	64	1
98B-86	3674	54.3	64	1
98B-88	3827	56.6	62	1
98B-90	3562	52.7	67	1
AC Nanda	2844	42.0	66	1
AC Phil	3256	48.1	63	1
AC Reed	2907	42.9	58	1
Mean	3524	52.1		

[1]1 = good, 9 = poor

Irrigated Wheat Variety Test

L. Townley-Smith[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

***Progress:** Ongoing*

***Locations:** Four soil associations in the Lake Diefenbaker region.*

***Objective:** To evaluate registered wheat varieties under irrigation.*

Wheat variety test plots were grown under irrigation at four locations on varying soil types in the Outlook area. Each site and soil association are as follows:

CSIDC: Bradwell very fine loam.
CSIDC offsite: Asquith sandy loam.
H. Jeske: Tuxford clay loam.
R. Pederson: Elstow loam.

The test was replicated four times.

Plots of 1.5 m x 4.0 m (5 ft x 13 ft) size were sown May 18 to May 26. All plots received 100 kg/ha N (90 lb N/ac) as 46-0-0 and 50 kg/ha P_2O_5 (45 lb P_2O_5/ac) as 11-52-0.

Harvest was taken from Sept. 17-20. Yields were estimated by harvesting the entire plot. The results are presented in Table 3.

Table 3. Yield and agronomic data for the irrigated wheat variety test.

Variety		Jeske site		Pederson site			CSIDC Off-station site			CSIDC site			Mean yield		
		Yield (kg/ha)	Height (cm)	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	kg/ha	bu/ac	% of Katepwa
Katepwa	CWRS	2703	103	2459	98	1	5535	107	1.5	5783	107	2	4120	60.9	100
AC Barrie	CWRS	2769	101	2700	90	1	5748	103	1	6180	106	1.3	4349	64.3	106
AC Domain	CWRS	2526	95	2265	83	1	5550	95	1	5844	96	2	4046	59.8	98
AC Intrepid	CWRS	2460	103	2843	87	1	6482	105	1	6563	106	1.8	4587	67.8	111
BW 252	CWRS	2987	92	2729	85	1	6199	90	1	6444	95	1.8	4589	67.9	111
AC Avonlea	CWAD	3328	128	3573	90	1	6820	95	1.5	6521	102	2	5061	74.8	123
AC Navigator	CWAD	2859	90	3197	82	1	5778	77	1	5508	85	1.8	4336	64.1	105
AC Pathfinder	CWAD	2895	97	3780	96	1	6360	92	2	5676	98	2	4669	69.0	113
AC Vista	CPS	3880	92	3465	84	1	6142	90	1.3	7882	93	1.8	5342	79.0	130
HY433	CPS	3130	89	2795	78	1	6155	84	1	6449	89	1.5	4632	68.5	112
HY 441	CPS	2475	93	3007	83	1	6093	89	1	6370	95	3.3	4486	66.3	109
AC Nanda	SWS	2962	95	2543	90	1	4750	90	1	6331	100	2.5	4147	61.3	101
Laser	CWES	2935	97	3629	93	1	6354	99	1	6560	103	1	4870	72.0	118

[1]1 = no lodging; 9 = completely lodged

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Saskatchewan Advisory Council Irrigated Wheat and Barley Regional Tests

L. Townley-Smith[1]

Progress: *Ongoing*

Objective: *To evaluate crop varieties in various regions of the province.*

The Saskatchewan Advisory Council wheat and barley regional tests were sown on the CSIDC off-station site on May 20. Plot size was 1.5 m x 4.0 m (5 ft x 13 ft). 100 kg/ha N (90 lb N/ac) as 46-0-0 and 50 kg/ha P_2O_5 (45 lb P_2O_5/ac) as 11-52-0 were side-banded at seeding. The plots were harvested on September 15.

Yield results for the CWRS, CPS, SWS, CWAD, and CWES market classes are shown in Table 4. Yield data for barley varieties under test is shown in Table 5.

This data is part of the information base from which the provincial variety guide is published.

Table 4. Saskatchewan Advisory Council irrigated wheat regional test, Outlook.

Variety	Yield kg/ha	Yield bu/ac	Variety	Yield kg/ha	Yield bu/ac
AC Abbey	5374	79.5	BW 251	5007	74.0
AC Avonlea	4844	71.6	BW 720	4972	73.5
AC Barrie	4294	63.4	DT 494	5393	79.7
AC Cadillac	5267	44.8	DT 498	5200	76.9
AC Corinne	5440	80.4	DT 513	4845	71.6
AC Crystal	4874	72.0	ES 04	4362	64.5
AC Elsa	5034	74.4	ES 13	4895	72.4
AC Intrepid	4667	69.0	Fielder	4717	69.7
AC Karma	5979	88.4	Glenlea	5265	77.9
AC Majestic	4897	72.4	HY 446	5298	78.3
AC Morse	5314	78.6	HY 639	5093	75.3
AC Nanda	4692	69.3	HY 961	6540	96.7
AC Navigator	4501	66.6	Katepwa	4243	62.7
AC Pathfinder	4431	65.5	Kyle	4381	64.8
AC Phil	4253	62.9	McKenzie	5556	82.1
AC Reed	5082	75.1	Prodigy	5378	79.5
AC Splendor	4863	71.9	PT 411	5430	80.3
AC Vista	5511	81.5	PT 413	4098	60.6
BW 238	4368	64.6	SWS 228	6589	97.4
BW 245	4559	67.4	SWS 234	4857	71.8

Table 5. Saskatchewan Advisory Council irrigated barley regional test, Outlook.

Variety	Yield kg/ha	Yield bu/ac	Variety	Yield kg/ha	Yield bu/ac
AC Bacon	6109	112.9	HB 504	5141	95.0
AC Harper	6639	122.7	HB 805	6568	121.3
AC Hawkeye	6103	112.8	Jaeger	6636	122.6
AC Rosser	7931	146.6	Mahigan	5260	97.2
BT 459	8473	156.6	Merit	6337	117.4
CDC Dawn	6507	120.2	Metcalfe	5812	107.4
CDC Dolly	6396	118.2	Robust	6848	126.6
CDC Fleet	5404	99.9	SD 422	7721	142.7
CDC Freedom	5386	99.5	SD 513	5748	106.2
CDC Gainer	5876	108.6	Stander	8507	157.2
CDC Kendall	5556	102.7	Stetson	7507	138.7
CDC Sisler	7073	130.7	Tercel	4768	88.1
CDC Stratus	6804	125.7	TR 129	---	---
Excel	8334	154.0	TR 139	6718	124.1
Foster	5622	104.0	TR 145	6406	118.4
Harrington	4473	82.7	TR 150	8041	148.6
HB 335	5664	104.7	TR 243	7907	146.1
HB 343	4247	78.5	Xena	7801	144.1

[1]CSIDC, Outlook

Evaluation of Durum Breeding Lines for Irrigation

J. Clarke[1], L. Townley-Smith[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

Progress: *Ongoing*

Locations: *Swift Current, Outlook*

Objective: *To identify superior durum wheat lines for production under irrigation in Saskatchewan.*

Field experiments were planted under irrigation near Outlook and Swift Current in 1999. These tests consisted of short and semidwarf durum F_6 and F_8 breeding lines, and the Pre-co-operative Durum Central 'A' Test. The results help us to select potential new varieties that perform well under irrigation. The best F_6 lines were sent to New Zealand for seed multiplication during the winter, and will be tested further in 2000. The F_8 lines that have good quality will be entered into 'A' level tests and the best lines from the Durum Central 'A' Test will enter the Durum 'B' Test (final test prior to the Durum Co-operative Test) in 2000.

The new variety AC Avonlea, registered in 1996 from our program, performed very well on irrigation and dryland. AC Avonlea has higher protein than other varieties. Certified seed is available for 2000. AC Avonlea, AC Melita, AC Navigator (tested as DT673) and Sceptre all have shorter straw than Kyle and Plenty. The 1999 Outlook yields relative to Kyle were 109 for AC Avonlea and AC Navigator, 103 for AC Morse, and 101 for AC Melita.

AC Navigator is a semi-dwarf line tested through this project at Outlook since 1991, and was tested in the Durum Co-operative Test in 1996 to 1998. It was granted interim registration in 1998 to permit market evaluation by the Canadian Wheat Board and Saskatchewan Wheat Pool. AC Navigator has shown good yield potential under both irrigation and dryland conditions. It has desirably stronger gluten than other Canadian durum varieties. AC Navigator has been well-received by customers in North America and Europe due to its premium quality. Significant acreage will be contracted in 2000 to provide commercial sales.

[1]*Semiarid Prairie Agricultural Research Centre, Swift Current*
[2]*CSIDC, Outlook*

Oilseeds Program

Oilseeds Program

Variety Evaluations

Western Canada Irrigated Canola Co-operative Tests NI1 and NI2

L. Townley-Smith[1], I. Bristow[2]

Progress: Ongoing

Objective: *To evaluate potential new canola varieties under irrigated conditions in western Canada.*

The canola co-operative tests were sown at SIDC on May 20 in 1.5m x 6.0m (5 ft x 20 ft) plots. Nitrogen was applied at 100 kg/ha (90 lb/ac) as 46-0-0, and phosphorus was applied at 50 kg/ha (45 lb/ac) as 11-52-0. All fertilizer was side-banded at the time of seeding. The plots were swathed on September 1 and combined September 13. Results are presented in Tables 1 and 2.

Irrigated Canola Variety Test

L. Townley-Smith[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

The canola variety tests were grown at four locations in the Outlook area. Each site and soil type are as follows:

CSIDC: Bradwell very fine loam
CSIDC offsite: Asquith sandy loam
H. Jeske: Tuxford clay loam
R. Pederson: Elstow loam

Progress: Ongoing

Locations: *Four soil associations in the Lake Diefenbaker area.*

Objective: *To evaluate registered canola varieties under irrigation.*

Canola varieties were tested for their agronomic performance under irrigation. Plots were seeded at four sites and with four replicates at each site.

1.5 m x 4.0 m (5 ft x 13 ft) plots were sown May 18 to May 26. All plots received 100 kg/ha N (90 lb/ac) as 46-0-0 and 50 kg/ha P (45 lb/ac) as 11-52-0. Harvest was taken from Sept. 2-8. Yields were estimated by harvesting the entire plot. The results are presented inTable 3.

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Table 1. Yield and agronomic data for the irrigated canola co-operative test NI1, Outlook.

Line	Yield (kg/ha)	Days to maturity	Height (cm)	Lodging rating[1]
AC Excel	2905	102	124	3.7
Defender	3347	103	128	3.3
Legacy	3216	102	116	3.0
AC Excel1	3342	101	125	3.7
ZNP009	3502	102	125	3.0
SW-P98107	3648	103	130	1.3
PHS98-636	4800	102	137	1.0
NS1539	4070	100	121	1.0
A98-9NR	3604	103	127	1.7
PR 5339	4330	100	118	2.0
ZCN70569	3807	101	138	2.0
SW B5001	3806	102	120	1.0
PR 5338	3278	100	115	2.7
SW B2677	3560	102	130	1.7
96-1519	3295	103	145	1.0
ZCN70583	3822	102	119	2.0
PR 4389	3862	99	115	2.7
SW B2674	3403	102	133	1.7
PHS98-641	4334	101	133	1.3
PR 5270	3149	101	118	3.3
SW A2665	3384	102	125	3.0
HCN 41	3395	104	116	2.0
SW B2678	4000	102	125	1.7
96-1671	3705	101	138	1.7
PR 5365	3539	102	123	1.7
96-2367	2968	102	110	2.3
SW B2695	3369	101	122	3.0
ZCN70570	4178	100	125	1.7
CNR186	3893	100	115	2.0
PRO1-98	3830	103	127	2.0
Check Mean	3156	102	123	3.3
Grand Mean	3645	102	125	2.1
CV (%)	8.9			

Table 2. Yield and agronomic data for the irrigated canola co-operative test NI2, Outlook.

Line	Yield (kg/ha)	Days to maturity	Height (cm)	Lodging rating[1]
AC Excel	3356	102	131	3.3
Defender	3717	101	132	2.5
Legacy	2895	101	118	2.8
CNR028	3927	100	126	3.0
SR 96279	3699	101	121	2.5
PHS98-727	4394	100	135	1.3
SW B2673	3658	102	124	1.3
PHS98-639	5068	100	147	1.0
PHS98-596	4019	101	149	1.8
PR 5358	3801	100	119	1.0
DP33-98	3820	101	130	1.0
PHS98-684	3915	101	136	1.0
PHS98-685	4467	101	139	1.0
PHS98-601	4126	101	139	1.3
SW B2670	3720	101	130	2.0
PHS98-730	4361	101	119	2.5
SW B2691	4084	101	136	1.0
96-2393	4162	102	133	1.0
96-2416	3826	102	133	2.8
CNR151	3699	101	129	1.8
SW B2694	4184	102	137	1.0
ZCN70553	4110	102	143	1.8
ZCN70567	4185	101	131	2.8
CN700564	3772	101	127	1.8
PR 5347	3709	101	126	2.0
DE001	3511	102	124	1.3
SW B2675	2889	101	111	2.8
DP44-98	3330	102	133	1.3
PHS98-640	4585	102	149	1.3
PR5208	3859	102	118	2.0
Check Mean	3322	101	127	2.8
Grand Mean	3895	101	131	1.8
CV (%)	8.6			

Table 3. Yield and agronomic data for the irrigated canola variety test.													
	Jeske site			Pederson site			Off-station site[1]	CSIDC			Mean yield		
Variety	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Yield (kg/ha)	Height (cm)	Lodging rating	kg/ha	bu/ac	% of Quantum
Quantum	3419	129	2.7	2831	141	2.8	2771	5108	144	2.3	3532	62.7	100
4.23	2909	119	3	3126	137	4.3	3762	4225	142	3.5	3505	62.2	99
45A51	2643	119	3.8	2255	119	5.3	3214	4350	126	7.3	3116	55.3	88
46A65	2681	117	2.3	2959	127	3.3	2447	4685	127	3.8	3193	56.7	90
CNS604	2474	104	4.3	2251	119	8.3	2392	3368	121	8.3	2621	46.5	74
Ebony	2998	136	2	2836	134	2.5	3504	4745	141	1.8	3521	62.5	100
Global	3032	116	2.3	2700	126	4.3	3349	4838	128	3.3	3480	61.7	99
InVigor 2153	3495	119	4.7	2638	124	5.8	4099	5243	137	5.5	3869	68.6	110
InVigor 2273	3543	126	3	2910	133	5.5	4265	3886	140	6	3651	64.8	103
LG 3295	2622	118	5.5	2373	125	8	3095	3412	133	7	2876	51.0	81
LG 3366	2958	120	2	2910	134	3	3775	5317	137	3.5	3740	66.4	106
LG 3235	2860	112	3.8	3055	118	4	2422	4575	126	3	3228	57.3	91
LG 3311	3069	111	1.7	3472	122	2.5	2760	4948	124	2.8	3562	63.2	101
Magellan	2876	119	3.3	2923	125	4	3580	4172	142	4.5	3388	60.1	96
Navigator	2685	115	3.7	2664	127	4.5	3233	4229	130	4.5	3356	59.5	95
OAC Dynamite	2704	110	2.3	3276	118	4	3485	4840	124	3	3576	63.4	101
Q2	2910	120	2	2737	126	6	3777	5058	130	5.3	3621	64.2	103
SW 02627	2641	113	3.3	2668	113	6.3	2377	4415	124	4	3025	53.7	86
SW A2662	2501	113	3	2488	115	4.8	2573	3988	129	6.3	2888	51.2	82
Synbrid 220	2348	125	2	2500	135	1.8	3408	3859	140	1	3029	53.7	86

[1]2 replicates only

Western Canada Irrigated Flax and Solin Co-operative Tests

L. Townley-Smith[1], I. Bristow[2]

Progress: *Ongoing*

Objective: *To evaluate new flax and solin varieties under irrigated conditions in western Canada.*

The flax and solin co-operative tests were sown May 28 in 1.5 m x 4.0 m (5 ft x 13 ft) plots on a sandy soil. Nitrogen was applied at 100 kg/ha (90 lb/ac) as 46-0-0, and phosphorus was applied at 50 kg/ha (45 lb/ac) as 11-52-0. All fertilizer was side-banded at the time of seeding. Plots were harvested October 6 with above average yields. Many of the varieties showed good lodging and disease resistance (Tables 4 and 5).

Table 4. Yield and agronomic data for the irrigated flax co-operative test, Outlook.

Line	Yield (kg/ha)	Yield % of Norlin	Rank	Height (cm)	1000 seed weight (g)	Lodging rating[1]	% oil
Vimy	2010	71	21	63	4.8	2.8	41.2
AC McDuff	2600	93	13	68	4.7	1.3	44.8
CDC Normandy	2810	100	4	63	5.1	1.8	40.9
Flanders	2750	98	9	64	4.4	2.3	42.1
NorLin	2810	100	5	62	5.0	1.5	40.4
FP 1069	2800	100	7	61	5.3	1.8	44.8
FP 1077	2640	94	11	62	4.8	1.5	41.2
FP 1082	2470	88	15	66	4.5	2.0	41.4
FP 1092	2720	97	10	67	5.0	1.3	43.1
FP 1094	2990	106	1	62	5.2	1.8	42.4
FP 1096	2360	84	17	62	5.4	2.0	44.8
FP 2000	2580	92	14	61	5.0	1.5	45.2
FP 2024	2990	106	2	66	4.4	1.5	43.3
FP 2025	2780	99	8	65	5.0	1.3	43.3
FP 2026	2800	100	6	61	4.9	1.0	45.2
FP 2031	2910	104	3	60	5.0	1.5	47.1
FP 2035	2470	88	16	62	5.4	2.0	43.8
FP 2036	2160	77	19	62	4.9	3.3	41.5
FP 2037	2050	73	20	60	5.7	3.3	42.0
FP 2041	2640	94	12	61	5.2	1.8	42.3
FP 2044	2290	82	18	60	4.4	1.5	42.9
Mean	2600	93		62.6	4.9	1.8	43.0
CV (%)	9.0			4.5	2.4	41.5	1.1
LSD (0.05%)	280			3.3	0.2	0.9	0.8

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Table 5. Yield and agronomic data for the irrigated solin co-operative test, Outlook.

Line	Yield (kg/ha)	Yield % of Linola 947	Rank	Height (cm)	Lodging rating[1]	% oil
Linola 947	2620	100	11	65	2.3	43.5
Linola 989	2750	105	4	65	1.0	41.9
Linola 1084	2840	108	1	65	1.5	44.8
SP 1089	2800	107	2	60	2.0	45.8
SP 2021	2720	104	6	60	2.3	43.5
SP 2022	2220	85	17	62	2.0	42.9
SP 2047	2660	101	9	63	1.0	48.0
SP 2048	2300	88	16	61	1.0	47.4
SP 2051	2770	106	3	64	1.5	45.0
SP 2052	2600	99	12	68	1.0	46.2
SP 2053	2740	105	5	67	1.0	44.9
SP 2054	2670	102	8	65	1.3	45.1
SP 2055	2680	102	7	66	1.3	45.7
SP 2056	2430	93	13	60	1.8	45.2
SP 2057	2160	82	18	62	2.0	47.7
SP 2058	2340	89	15	64	1.5	48.1
SP 2059	2410	92	14	63	2.0	47.7
SP 2060	2140	82	19	59	3.0	42.0
SP 2061	2040	78	20	59	2.0	40.6
SP 2062	2640	101	10	61	1.0	42.1
Mean	2530			62.7	1.6	41.4
CV (%)	9.0			5.4	21.1	0.8
LSD (0.05%)	320			4.8	0.5	0.7

Irrigated Flax and Solin Variety Test

L. Townley-Smith[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

Progress: Ongoing

Locations: Four soil associations in the Lake Diefenbaker area.

Objective: To evaluate registered flax and solin varieties under irrigation.

Flax and solin varieties were tested for their agronomic performance under irrigation at four locations in the Outlook area. Each site and soil type are as follows:

CSIDC: Bradwell very fine loam
CSIDC offsite: Asquith sandy loam
H. Jeske: Tuxford clay loam
R. Pederson: Elstow loam

Plots were seeded with four replicates at each site.

1.5 m x 4.0 m (5 ft x 13 ft) plots were sown May 18 to May 26. All plots received 100 kg/ha N (90 lb/ac) as 46-0-0 and 50 kg/ha P (45 lb/ac) as 11-52-0. Harvest was taken from September 30 to October 8. Yields were estimated by harvesting the entire plot. The results are presented in Table 6.

Table 6. Yield and agronomic data for the irrigated flax and solin variety test.

	Jeske site		Pederson site			Off-station site			CSIDC			Mean yield		
Variety	Yield (kg/ha)	Height (cm)	Yield (kg/ha)	Height (cm)	Lodging[1] rating	Yield (kg/ha)	Height (cm)	Lodging[1] rating	Yield (kg/ha)	Height (cm)	Lodging[1] rating	kg/ha	bu/ac	% of AC McDuff
Oilseed flax														
AC McDuff	3218	62	2959	70	1.8	3278	57	1	3918	72	1.8	3268	51.8	100
AC Carnduff	2580	61	2987	72	1.5	3178	53	1	3378	68	1	3031	48.0	93
AC Emerson	3041	61	2586	65	3	3051	54	2	3263	67	4	2985	47.3	91
AC Watson	2722	57	2178	64	1.5	3155	52	1	3758	63	1.8	2703	42.8	83
CDC Arras	2756	61	2524	65	3.3	2995	57	1.3	3005	66	3.8	2820	44.7	86
CDC Bethune	2981	64	2650	68	1.8	3449	56	1.8	3886	73	2.3	3242	51.3	99
CDC Normandy	2837	62	2817	70	2	3562	57	1	3622	66	2.8	3210	50.8	98
CDC Triffid	2689	61	2925	66	1.8	3288	59	1.5	3254	68	4.5	3039	48.1	93
CDC Valor	2611	60	2558	68	1.3	2890	55	2.8	2883	64	4.5	2736	43.3	84
FP 1048	2641	59	3050	70	1.3	3030	53	1	3527	72	2.8	3062	48.5	94
NorLin	2745	64	2981	69	1.8	3181	59	1.3	2009	68	2.3	2729	43.2	84
Solin														
Linola 1084	2757	65	2754	73	1.5	3241	56	1	3694	73	3	3112	49.3	95

[1]0=good; 9=poor

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Sunflower Regional Trial

L. Townley-Smith[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year three of five*

Location: *Outlook*

Objective: *This trial is part of a multi-site regional effort to determine the yield of conventional height oilseed sunflowers.*

This was the only irrigated site and as such did not grow dwarf early maturing sunflowers but grew two confectionary cultivars. Confectionary sunflower seed is a specialty crop with significant potential but a limited market.

Producers require information on the relative performance of sunflower varieties to aid them in planting decisions. Sunflower trials had not been run under irrigation for several years and new genetic material has been developed during this time period. This trial provides information for recommendations made to producers.

Sunflowers were planted June 8 in two-row plots 60 cm (24") apart and 6 m (19.7 ft)long. Plant numbers were adjusted to a constant number by hand thinning. All heads were bagged after flowering to prevent bird damage. Combining was delayed until November 24, which in many years would cause harvest problems.

Yields were low. Although the heads appeared to have normal seeds, the shells were almost entirely unfilled. As a result usable yield data was not collected.

[1]CSIDC, Outlook

Forages Program

Forage Program

Turf Grass Seed Program

There is a large turf grass seed market both in North America and Europe. Western Canada can become the low cost supplier of seed if production packages can be developed that result in yields similar to traditional growing areas.

This program seeks to develop information on establishment, weed control and post-harvest management which will allow producers to obtain high seed yields for turf grass species.

Production Package for Bluegrass

B. Coulman[1], J. Vermette[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Effect of Bluegrass Seed Production on Yield of Subsequent Crops

***Progress**: Final year of three*

***Objective:** To refine a seed production package for bluegrass seed to ascertain the potential effectiveness of weed, insect and residue management.*

Perennial grass crops add significant amounts of root material to the soil which can stabilize soil structure and reduce erosion. There may be reductions in weed populations and lower disease pressures. These trials are designed to quantify these effects and add to the potential value for the grass seed crop in the farming system.

A seed crop of bluegrass was taken. Tillage and Roundup treatments were implemented on August 18. Separate trials were laid out for bean and potato in a four-replicate split plot design with main plots being the year of breaking and subplots being tillage treatments. Grass seed will be harvested each season and the following treatments applied:

TL1) Roundup @ 1.5 L/ac, then cultivate in August and again the following spring
TL2) Spray with Roundup in August and cultivate prior to seeding
TL3) Rototill in August and spray with Roundup @ 0.5 L/ac in spring
TL4) Rototill in August and again in spring.
Tillage treatments are 2 m X 6 m.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*CSIDC, Outlook*

The trials are designed so that the rotation will be run for three seasons.

Plot Layout for Trial (1 rep)				
1997	1998	1999	2000	2001
tillage	potato	bean		
tillage	bean	potato		
	tillage	potato	bean	
	tillage	bean	potato	
		tillage	potato	bean
		tillage	bean	potato

The 1998 bean crop was severely damaged by an overdose of Edge while the potato crop was severely damaged by potato beetles. No yields are available. Furthermore, grass sod after several tillages caused potato seeding problems.

Due to the problems described above and the fact that part of the trial was cultivated by mistake, this trial was abandoned in 1999. It will not be re-established due to lack of time remaining in the project.

Production Package for Annual and Perennial Ryegrass and Tall Fescue

B. Coulman[1], J. Vermette[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year three of five*

***Objective:** To develop a production system for producing seed of perennial ryegrass and tall fescue as biennial crops and annual ryegrass as an annual crop.*

Establishment and Crop Rotation

Profitable production of grass seed depends on the establishment of good stands. Most grasses do not produce seed in the year of planting and, thus, stands must be kept for several years to compensate for the loss of income in the establishment year, or a companion crop can be used in the establishment year. Previous research with bluegrass has shown that flax was the most suitable companion crop since it is less competitive. The fine fescues can tolerate Poast Flax Max, therefore flax may be a good choice since these species have weak seedlings. Tall fescue is a much more competitive species and can tolerate Puma, and thus, wheat may be the best companion crop. Perennial ryegrass can be planted after the harvest of an early maturing crop or is broadcast into a standing crop prior to harvest.

For trials established in 1997, the 1997 and 1998 results can be found in the 1998 report. The tall fescue trial was harvested in 1999 (results follow), while the perennial ryegrass trial was abandoned due to winterkilling. The 1998 seedings failed to establish and were abandoned. New trials were successfully established in 1999 with spring seedings and companion crops established the first week of June, and grasses broadcast into standing crops the middle of August.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*CSIDC, Outlook*

In the 1997 seeded trial, tall fescue seed yields were higher in 1999 than 1998 (Table 1). There were no differences among spring seeded treatments, while fall broadcast seedings failed to establish.

Table 1. Tall fescue establishment and rotation trial.

Treatment	1998 mean seed yield (kg/ha)	1999 mean seed yield (kg/ha)
AC Taber/Tall fescue spring seeded	500	994
AC Barrie/Tall fescue spring seeded	470	979
No companion crop/Tall fescue spring seeded	550	896
AC Pennant/Tall fescue broadcast in August	0	0
AC Pennant/Tall fescue broadcast in August	0	0
Mean		574
CV (%)		22
LSD (0.05)		240

Table 2. Companion crop yield for the 1999 perennial ryegrass establishment and crop rotation trial.

Treatment	Companion crop yield	
	kg/ha	bu/ac
Barley/PRG spring seeded	4234	78
Barley/PRG fall seeded	4206	78
Mustard/PRG fall broadcast	2143	38
Mustard/PRG spring seeded	2099	37
Canola/PRG fall broadcast	1878	33
Canola	1495	27
Canola/PRG spring seeded	1349	24
Mean	2486	
CV (%)	29	
LSD (0.05)	1072	

Barley, wheat, mustard and canola yields are reported in Tables 2 and 3 for the 1999 seeded trials. Visually, both perennial ryegrass and tall fescue appeared to be well established in spring seeded treatments.

There were few established seedlings in fall broadcast treatments, likely due to the difficulty in seeding through a thick standing crop and the late removal of the crop (maturity delayed due to cool weather).

Table 3. Companion crop yield for the 1999 tall fescue establishment and crop rotation trial.

Treatment	Companion crop yield	
	kg/ha	bu/ac
HRS wheat/TF spring seeded	3990	59
Mustard/TF broadcast in August	2487	44
CPS wheat/TF spring seeded	2063	31
Canola/TF broadcast in August	1810	32
Mean	2587	
CV (%)	13	
LSD (0.05)	527	

Herbicide Minor Use Registration for Seedlings of Tall Fescue, Perennial Ryegrass and Annual Ryegrass

Weed Control in Tall Fescue Seedlings

Courtney tall fescue was planted at 8 kg/ha in rows 20 cm apart on May 14, 1997, into a seedbed prepared by pre-plant application of Roundup. Both broadleaf and grassy herbicide trials were four replicate RCBD. Herbicides were applied June 17 when the plants were in the 4-5 leaf stage. There was a significant population of chickweed in the grass weed control trial. This was treated with Refine Extra three weeks after the grassy weed control products were applied. This delayed application resulted in significant weed competition. Hand weeding was done on the weeded check but caused some crop damage. The check was abandoned. The trials were clipped to a height of 15 cm four times during the growing season to control tall weeds. Weed control ratings were done using a visual damage rating as per the Expert Committee on weeds, where 0 indicates no damage.

The experiments were repeated in 1998. Courtney tall fescue was planted at 8 kg/ha in rows 20 cm apart on June 1, 1998, into a seedbed prepared by pre-plant application of Roundup.

Table 4. Tolerance of Tall fescue seedlings to broadleaf herbicides.

Treatment	Rate (kg/ha)	Crop damage rating[1] 14 day	Crop damage rating[1] 28 day	Seed yield kg/ha	Seed yield lb/ac
Refine Extra 2,4-D ester Agral 90	0.015 0.550 0.2% v/v	5.5	4.5	1676	1490
Target	0.595	5.0	6.5	1437	1280
Refine Extra Agral 90	0.015 0.2% v/v	6.0	5.5	1433	1280
Buctril M	0.560	2.5	3.0	1406	1250
Attain	1.330	5.0	4.0	1394	1240
Accord Merge	0.100 1% v/v	3.5	4.0	1394	1240
Target	1.190	4.5	7.5	1393	1240
Accord 2,4-D ester Merge	0.100 0.550 1% v/v	4.5	3.0	1389	1240
Accord Merge	0.200 1% v/v	7.5	4.5	1373	1220
Check				1343	1200
Attain	0.665	4.0	4.5	1328	1180
Refine Extra Agral 90	0.030 0.2% v/v	7.0	5.5	1279	1140
Banvel 2,4-D amine	0.140 0.140	5.0	7.0	1224	1090
Mean		5	5	1384	
CV (%)		39	37	9	
F-value		2.1*	2.6*	3.1**	
LSD (0.05)		3	3	172	

[1]0 = no damage; 100 = complete control
***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.

Table 5. Tolerance of Tall fescue seedlings to grass weed herbicides.

Treatment	Rate (kg/ha)	Crop damage rating[1] 14 day	Crop damage rating[1] 28 day	Seed yield kg/ha	Seed yield lb/ac
Puma 892 Buctril M	1.304	6.0	9.0	1509	1340
Puma 892	0.184	7.0	8.5	1453	1290
Puma 892 Buctril M	0.652	6.5	5.5	1449	1290
Weedy check				1428	1270
Hand weeded check				1406	1250
Puma 892	0.092	7.0	10	1404	1250
Puma	0.092	7.0	11.5	1384	1230
Puma Buctril M	0.652	6.0	6.5	1336	1190
Avenge 200-C	0.840	7.5	6.5	1156	1030
Mean		7	8	1392	
CV (%)		34	34	12	
F-value		0.3	2.4	1.6	
LSD (0.05)		NS	NS	NS	

[1]0 = no damage; 100 = complete control
***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.

Both broadleaf and grassy herbicide trials were four replicate RCBD. Herbicides were applied June 17, 1998 when the plants were in the 4-5 leaf stage.

Seed yields and crop damage for the 1998 seedling trial are reported in Tables 4 and 5. Crop damage was minimal for both the broadleaf and grass herbicides, being around 10% or less for both recording dates. Seed yields were high in 1999, with a mean of close to 1400 kg/ha in both trials. The only treatment that was significantly different (higher than) the check was Refine Extra and 2,4-D.

Minor Use Registration for Established Stands of Perennial Ryegrass and Tall Fescue

Weed Control in Tall Fescue Established Stands

Courtney tall fescue was established in May of 1998. Several clippings were used to control weeds during the summer of 1998 and excellent stands were established. Spray treatments were applied in mid-June of 1999. Visual ratings of crop damage were made 14 and 28 days after treatment (d.a.t.). Seed was harvested on July 30.

Established tall fescue was tolerant of all herbicide treatments (Tables 6 and 7). A low % damage was observed for Avenge 200C 14 d.a.t., but otherwise damage ratings were 0. Seed yields were moderate and there were no significant differences from the check for any herbicide treatment.

Table 6. Tolerance of established Tall fescue to grass weed herbicides.

Treatment	Time of application	Rate (kg/ha)	Crop damage rating[1]		Seed yield	
			14 day	28 day	kg/ha	lb/ac
Hand weeded check					747	665
Avenge 200-C	After elongation	1.682	0	0	710	630
Puma Super	After elongation	0.184	0	0	694	615
Avenge 200-C	After elongation	0.841	0	0	688	610
Puma Super Curtail M	4 - 5 leaf stage	0.092 0.660	0	0	678	605
Puma Super	After elongation	0.092	0	0	657	585
Weedy check					643	570
Puma Super	4 - 5 leaf stage	0.092	0	0	626	555
Avenge 200-C	4 - 5 leaf stage	0.84	0.5	0	613	545
Avenge 200-C	4 - 5 leaf stage	1.680	2.5	0	609	540
Puma Super	4 - 5 leaf stage	0.184	0	0	602	535
Puma Super Curtail M	After elongation	0.092 0.660	0	0	504	450
Mean			0.3		648	
CV (%)			64		24	
F-value			3.7**		0.7	
LSD (0.05)			1.2		NS	

[1]0 = no damage; 100 = complete control
***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.

Table 7. Tolerance of established Tall fescue to grass weed herbicides.

Treatment	Rate (kg/ha)	Herbicide action (%)		Seed yield	
		14 day	28 day	kg/ha	lb/ac
Banvel 2,4-D amine	0.280 0.800	80	80	1055	940
Banvel 2,4-D amine	0.140 0.400	81	81	997	890
Accord Merge	0.200 1% v/v	58	59	977	870
Accord Merge	0.100 1% v/v	58	58	929	825
Attain A Attain B	0.210 1.120	71	79	863	770
Accord 2,4-D ester Merge	0.100 0.550 1% v/v	58	75	809	720
Prestige A Prestige B	0.288 1.320	82	77	802	715
Prestige A Prestige B	0.144 0.660	81	88	790	705
Weedy check				770	685
Attain A Attain B	0.105 0.560	69	80	716	635
Mean				871	
CV (%)				23	
F-value				1.2	
LSD (0.05)				NS	

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.

Weed Control in Perennial Ryegrass Established Stands

The perennial ryegrass trial seeded in 1998 failed to establish, thus there was no trial on which to apply herbicide treatments in 1999.

Residue Management/Fertility/Insect Control in Tall Fescue

A trial was set up in August of 1999 on a 1997 established tall fescue stand which had been previously used for herbicide trials. This stand was in good condition having yielded around 900 kg/ha (800 lb/ac) in 1999.

Treatments were applied in a factorial randomized complete block design with four replications. Number of heads, % of silvertopped heads and seed yield will be determined in 2000.

Objective: *To refine a system of residue management, nitrogen fertilization and insect control for tall fescue seed production fields.*

Treatments:

- N fertility (mid-Sept, 1999) - *0, 75 and 150 kg/ha.*
- Residue management (late-Aug, 1999) - *none; mow close and remove; burn.*
- Silvertop control (late May, 2000) - *cygon; check*

Seeding Date Trials for Perennial, Italian and Westerwolds Ryegrass

Objective:
- To determine whether fall dormant seeding will promote seed production in Italian and perennial ryegrass.
- To determine whether all dormant seeding will promote early spring growth and earlier seed production in Westerwolds ryegrass compared to spring seedings.

Late fall (dormant) seedings have worked well with canola. They also show potential for ryegrass seed crops. Annual (westerwolds) ryegrass has produced fairly high yields from spring seedings, but yields could perhaps be increased by dormant seedings. Italian and perennial ryegrass do not produce any heads in the year of seeding and must overwinter to become vernalized and produce seed the following year. Italian ryegrass will not survive our winters and perennial ryegrass is only moderately winterhardy. For dormant seedings of these latter two species, seedlings germinating early in the spring may become vernalized and subsequently produce heads and seed. This would eliminate the need to overwinter plants and create an effective annual production system for these grasses.

Seeding Dates:
Polymer coated seed - *late October, 1998*
Uncoated seed - *late October, 1999*
Uncoated seed- *May, 1999*
Varieties:
Westerwolds - *Barspectra*
Italian - *Bar.LM.6MY, Maris Ledger, Bartali, Bartissimo*
Perennial - *Yatsin*
Design:
Randomized complete block with 4 reps.

Soil crusting occurred in the spring of 1999, which severely reduced the stand density for the dormant seeded treatments. Despite these lower densities, seed yields of the dormant seeded Barspectra westerwolds ryegrass exceeded 1200 kg/ha (1070 lb/ac) (Table 8). These yields were twice as high as those for spring seedings. Yields of Italian ryegrass were lower, probably due to the poor stand densities and cultivar variation.

6 MY, which has a low vernalization requirement, was the highest yielding Italian ryegrass (just over 300 kg/ha), which would not be considered economic. Yatsin perennial ryegrass produced low yield ranging from 14-168 kg/ha (12-150 lb/ac). The spring seeded treatment had the highest yields, indicating that this is a low vernalization requirement cultivar.

Coated seed showed no consistent advantage over uncoated seed in dormant seedings. This is likely due to the late seedings. If seedings were done early to mid-October, when soil temperatures were high enough for germination, the coated seed may have shown an advantage.

These trials demonstrated considerable advantage for dormant seedings of Westerwold (annual) ryegrass. They also indicate that it is possible to produce seed of Italian ryegrass by dormant seeding this species; thus this tender species doesn't have to overwinter to be vernalized. The soil crusting problem must be overcome to properly assess the yield potential of dormant seeded Italian and perennial ryegrass.

An identical trial was seeded in early November of 1999.

Table 8. Yield and agronomic data for the Ryegrass dormant seeding trial.

Cultivar	Species	Treatment	Seeding time	Plant density (#/m²)	50% heading[1]	Seed yield kg/ha	Seed yield lb/ac
Barspectra	Westerwold's	Uncoated	Fall '98	80	88	1181	1050
Barspectra	Westerwold's	Coated	Fall '98	84	88	1141	1015
Barspectra	Westerwold's	None	Spring '99	544	99	599	530
6MY	Italian	Uncoated	Fall '98	306	108	309	275
6MY	Italian	Coated	Fall '98	126	110	313	280
6MY	Italian	None	Spring '99	638	138	0	0
Bartali	Italian	Uncoated	Fall '98	28	138	29	26
Bartali	Italian	None	Spring '99	29	138	3	3
Bartali	Italian	Uncoated	Fall '98	528	n/a	4	4
Bartissimo	Italian	Uncoated	Fall '98	64	129	158	1405
Bartissimo	Italian	None	Spring '99	24	138	117	105
Bartissimo	Italian	Uncoated	Fall '98	496	138	253	225
Maris Ledger	Italian	Uncoated	Fall '98	16	n/a[2]	55	50
Maris Ledger	Italian	None	Spring '99	14	n/a	107	95
Maris Ledger	Italian	Uncoated	Fall '98	232	138	69	60
Yatsin	Perennial	Uncoated	Fall '98	26	138	63	55
Yatsin	Perennial	None	Spring '99	8	138	14	10
Yatsin	Perennial	Uncoated	Fall '98	238	121	168	150
		Mean		193		260	
		cv (%)		48		55	
		F-value		21.8*		26.4**	
		LSD (0.5)		131		200	

[1]days after April 1st
[2]n/a = no heads produced
***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.

Production Package for Slender Creeping Fescue and Chewings Fescue

B. Coulman[1], J. Vermette[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Residue Management, Nitrogen Fertility and Insect Control in Chewings and Slender Creeping Red Fescue

***Progress:** Year one of three*

***Objective:** To develop a cost effective method of establishing and managing slender creeping fescue and chewings fescue.*

A trial was set up in August of 1999 on 1997 established stands of chewings and slender creeping red fescue which had been previously been used for herbicide trials. The chewings fescue stand was in good condition having yielded close to 400 kg/ha (355 lb/ac) in 1999. The slender creeping red fescue stand was not as thick, so no seed was harvested in 1999.

Treatments:
- N fertility (mid-Sept, 1999) - *0, 75 and 150 kg/ha.*
- Residue management (late-Aug, 1999) - *none; mow close and remove; burn.*
- Silvertop control (late May, 2000) - *cygon; check*

Treatments were applied in a factorial randomized complete block design with four replications. Number of heads, percentage of silvertopped heads and seed yield will be determined in 2000.

Herbicide Minor Use Registration for Chewings and Slender Creeping Fescue

Weed Control in Fine Fescues (seedlings)

The fine fescues were planted at Outlook on June 6, 1997, at 4 kg/ha (3.5 lb/ac) on 20 cm row spacings. The broadleaf and grass weed control protocols were arranged in four replicate RCBD. Willma chewings fescue and Basic Barcrown slender creeping fescue were sown at a depth of 0.5 cm (0.2 in). Both the broadleaf and the grass weed control products were applied in 100 L/ha of solution on July 2, 1997. The crop was in the 4th leaf stage. Crop tolerance ratings were made on July 9, July 17 and August 6. Weed-free plots were maintained by regular hand weeding. All other plots except the weedy check were mowed for weed control. Weed control ratings were done using a visual damage rating using the Expert Committee on Weeds protocol (0 = no damage). The July 9 ratings for both species and July 17 ratings for slender creeping fescue are not shown since no effects were observed.

Results can be found in the 1998 report. No new seedings were done in 1998 and 1999.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*CSIDC, Outlook*

A Crop Diversification Opportunity: Potential of Ryegrass (*Lolium spp.) as a Seed Crop under Irrigation in Saskatchewan*

B. Coulman[1], H. Leoppky[1], D. Murrell[2], G. Kruger[3]

Funded by the
Canada-Saskatchewan Partnership Agreement of Water-Based Economic Development (PAWBED)

***Progress**: Final year of four*

***Objective:** The objective of this project is to evaluate the potential of, and to develop basic agronomic packages for ryegrass (Lolium spp.) as a new multi-purpose crop in Saskatchewan.*

The specific objectives are:
- To evaluate the potential of Italian, Westerwolds and perennial ryegrass for seed production under irrigated conditions.
- To evaluate agronomic practices such as companion cropping and weed management which may be constraints to the development of a ryegrass seed industry.

Results - 1996

Westerwolds, the only annual ryegrass type tested, was the only species which produced seed in 1996. Yields were variable with a range of just over 600 to almost 1200 kg/ha (1070 lb/ac). The standard cultivar Aubade produced the highest seed yield. There were no significant difference between three rates of seeding. Harvest proved to be a problem as the plants produce reproductive tillers throughout the growing season. As a result, the optimum time for harvest is difficult to determine. The many green seeds present in the samples necessitates drying and results in decreased germination.

Italian ryegrass plots were harvested for forage with almost 10 tonnes DM/ha (4.5 tons/ac) being produced by the cultivar Maris Ledger. Forage yield was not affected by seeding rate.

The greatest number of grass tillers was produced using no companion crop. Flax was generally more competitive with wheat, and wheat outyielded flax. Both companion crops yielded more at a high seeding rate. Italian ryegrass proved to provide the most competition to the companion crops, resulting in the lowest yields for wheat and flax.

Results - 1997

Seed yields of Westerwold ryegrass was lower in 1997 that 1996 due to hot weather in July and August. Aubade was the highest yielding cultivar in both years. There were no significant differences in the yield of Aubade seeded at five different rates and three different row spacings. Higher seeding rates and closer row spacing did not increase synchrony of head ripening. Westerwold ryegrass

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*Newfield Seeds, Nipawin*
[3]*Cargill Grain, Rosetown*

produces an economic yield consisting of both seed and forage production in the same year. An Italian ryegrass cultivar trial seeded in 1996 was winterkilled, thus no seed was harvested in 1997.

Seed harvested from a perennial ryegrass cultivar trial seeded in the spring of 1997 produced highly variable yields. A seeding rate trial of Norlea and Barlinda perennial ryegrass showed no significant differences in yield amongst rates of 4, 8, and 12 kg/ha. For both cultivars, the 8 kg/ha (7 lb/ac) rate was numerically superior.

In 1996, a trial was seeded to compare the yields of Italian and perennial ryegrasses and tall fescue in spring and fall seedings and under companion crops in spring seedings. Italian ryegrass yields were low due to winterkill, but fall seeding was superior to spring seeding. Spring seedings under companion crops were generally superior to spring seeding with no companion crop. Fall seedings of perennial ryegrass resulted in higher yields than most spring seeded treatments. There were no significant differences for tall fescue, however, the trends were opposite to the ryegrass results with the spring seeded, no companion treatment having the highest numerical yield.

Results - 1998

In 1998, Magnum and Andrea numerically outyielded the standard cultivar Aubade. An Italian ryegrass cultivar trial seeded in spring 1997 was completely winterkilled, thus no seed was harvested in 1998.

Seed was harvested in 1998 from a perennial ryegrass cultivar trial seeded in the spring of 1996. Yields were about one-third less than those of 1997 for this trial due to considerable winterkilling. Yields were highy variable. A similar test seeded in 1997 was completely winterkilled; no seed was harvested in 1998.

Fall seedings of tall fescue were clearly inferior to spring seeded treatments. Pure stands were generally higher yielding than the companion crop treatments among the spring treatments.

In 1997, a trial to examine dormate seedings of the ryegrassed was established. Advance Westerwold was sown for comparison with the dormant seedings. Spring seeded Advance Westerwold produced low yields. For dormant seeding the yield was almost doubled. A forage cut lowered the seed yield of the dormant seeding by about one-third. Forage residue yield and protein content of this material results in moderate forage value.

In 1998, the dormant seedings of Italian ryegrass produced seed with Bufor yielding higher than Sikem. Seed yield of this type of ryegrass was reduced with spring cutting. Forage residue was higher that for Advance Westerwold ryegrass. Napolean perennial ryegrass produced few heads in 1998 and did not have any harvestable seed.

Results - 1999

An additional dormant seeding trial was established in 1998. Stand density for dormant seeded treatments was severely reduced due to soil crusting. Despite low densities, seed yields of dormant seeded Barspectra Westerwold was twice those of spring seedings. Italian ryegrass yields were lower than 1998 due to poor stand densities and cultivar variation. 6MY was the highest yielding Italian ryegrass.

There seemed to be no consistant advantage of coated seed over uncoated seed in dormant seedings.

Conclusions

1. *Westerwold ryegrass:*

   Seed yields of 1000 kg/ha (900 lb/ac) or more are possible,however, variety choice is important. There is significant forage value in harvest residue and fall regrowth. There also seems to be trend towards higher yields from a 10 cm (4 in) row spacing and a seeding rate of 12 kg/ha (10.5 lb/ac). Dormant seedings show potential for almost doubling seed yields over spring seedings.

2. *Italian ryegrass:*

   Spring seedings, with or without companion crop, are easily winterkilled. August seedings showed some plant survival, but seed yields were not economic. Dormant seedings showed promise to produce and economic yield for some cultivars of this type, but soil crusting may be a problem. Crusting problems could be avoided by no-till seeding.

3. *Perennial ryegrass:*

   Optimum seeding rate is 8 kg/ha. Pure spring seedings were killed 1 year in 2. Overwintering was better in seedings under companion crops. Late summer seedings has good establishment and survival. Yields were often higher that spring seedings. Dormant seedings produced little or no seed. Irrigated stands should be seeded in August, or in spring under a companion crop. Yields ranged from 0 to >600 kg/ha (540 lb/ac), thus variety choice is important.

Specialty Crops Program

Pulse Crops

Agronomic Investigations

Varietal Investigations

Alternate Crops

Specialty Crops Program

Pulse Crop Program

The pulse crop program at the CSIDC is designed to evaluate the adaptability of pulse crops for irrigation, and to develop and refine production practices for irrigated conditions. This is achieved by conducting varietal evaluations and agronomic trials.

Locations: CSIDC: SW 15-29-08-W3 Off-station: NW 12-29-08-W3

Agronomic Investigations

Response of Irrigated Field Pea and Dry Bean to Potassium Fertilizer

T. Hogg[1], M. Pederson[1]

Funded by the Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year three of three*

***Objective:** To determine the effect of potassium fertilizer on yield and seed quality of irrigated pea and dry bean.*

Adequate soil fertility is required for optimum production of pulse crops which remove large quantities of the macronutrients N, P, K and S. The requirement for potassium fertilizer applications for irrigated pea and dry bean production is not adequately known. For pea, response may occur under conditions of cool soil temperatures associated with early seeding. For dry bean, little is known about the soils ability to supply potassium during the rapid vegetative growth stage.

A potassium fertilizer response trial was established in the spring of 1999 at the CSIDC. Separate trials were established for dry bean and pea. Treatments included potassium rates of 0, 10, 20, 30, 40 and 50 kg K_2O/ha (9, 18, 27, 36 and 45 lb K_2O/ac) applied as a side band application at seeding. Potassium chloride (0-0-60) was the source of potassium. All plots also received a side band application of 50 kg N/ha (45 lb N/ac) as urea (46-0-0) and 45 kg P_2O_5/ha (40 lb P_2O_5/ac) as monoammonium phosphate (12-51-0) at seeding. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean was row crop seeded at a target plant population of 30 seeds/m^2 (105 lb/ac) using a 60 cm (24 in) row spacing. The treatments were arranged in a randomized complete block design with four replicates. Each treatment measured 2.4 m x 6 m (8 ft x 24 ft).

[1]CSIDC, Outlook

Current soil test recommendations indicated the requirement for 25-30 lbs P_2O_5/ac for both pea and dry bean grown under irrigated conditions. As well, there was a recommendation of 20-30 lbs N/ac for irrigated dry bean.

Table 1. Spring soil analysis: Pea and dry bean potassium fertilizer response trial.

Crop	Depth (in)	pH	1:2 E.C. dS/m	NO_3-N	P	K	SO_4-S
				lb/ac			
Pea	0 - 12	8.3	0.5	55	79	626	71
	12 - 24	8.4	0.5	55			79
Dry Bean	0 - 12	8.3	0.2	18	74	850	37
	12 - 24	8.5	0.4	18			51

Table 2. Yield response of irrigated Carneval pea to potassium fertilizer.

K_2O rate		Yield		Seed weight (mg)	Plant stand #/m²	Plant height (cm)
kg/ha	lb/ac	kg/ha	lb/ac			
0	0	3633	54.0	189	62	87
10	9	3690	54.8	180	61	90
20	18	3607	53.6	190	63	90
30	27	3663	54.4	180	59	90
40	36	3633	54.0	191	64	92
50	45	3569	53.0	189	58	90
LSD (0.05)		NS[1]	NS	NS	NS	NS
CV %		7.6	76	4.2	5.1	7.2

[1]not significant

Table 3. Yield response of irrigated Othello pinto bean to potassium fertilizer.

K_2O rate		Yield		Seed weight (mg)	Plant stand #/m²	Plant height (cm)
kg/ha	lb/ac	kg/ha	lb/ac			
0	0	1312	1169	293	30	45
10	9	1147	1022	293	32	44
20	18	1087	969	286	30	42
30	27	1249	1113	289	30	45
40	36	1301	1159	282	30	48
50	45	1250	1114	292	30	44
LSD (0.05)		NS[1]	NS	NS	NS	NS
CV %		14.5	14.5	2.9	8.7	6.1

[1]not significant

The growing season in 1999 was cooler than normal with the first killing frost registered in mid-September. Growing conditions were less than ideal for dry bean production. There was no observed difference among the potassium fertilizer treatments in days to flowering or maturity for either pea or dry bean. Pea required 56 days for 10% flowering and 90 days to reach maturity. Dry bean required 66 days for 50% flowering and 118 days to reach maturity. There was very little disease present in either crop.

There was no effect of potassium fertilizer application on yield, seed size, plant stand or plant height for Carneval pea (Table 2) or for Othello dry bean (Table 3). Pea yield was low for irrigated production. The very low dry bean yield was due to the cool growing conditions and early fall frost experienced in 1999.

Preliminary indications are that the current soil test guidelines correctly predict the potassium requirements of irrigated pea and dry bean. Monitoring of soil fertility through an adequate soil testing program is the best way to determine fertilizer requirements.

Response of Irrigated Pea and Dry Bean to Micronutrient Fertilizer

T. Hogg[1], M. Pederson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year three of five*

***Objective:** To determine the effect of soil and foliar applied copper, zinc and boron micronutrient fertilizer on yield and seed quality of irrigated pea and dry bean.*

Pulse crops require adequate soil fertility to maintain optimum growth and yield. Large quantities of the macronutrients are removed by pulse crops. The micronutrients are just as essential for optimum growth and yield although they are required in much smaller quantities. Micronutrient requirements are dependent on both plant uptake and soil availability. Generally, levels of soil micronutrients have been considered adequate. Response may occur under certain conditions, such as zinc application to dry bean on high pH soils, or if early season weather is cool and wet.

A micronutrient fertilizer response trial was established in the spring of 1999 at the CSIDC. Separate trials were established for dry bean and pea. Treatments included three micronutrient fertilizer sources (copper, zinc and boron) side-banded during the seeding operation and foliar applied at flower initiation, plus a control. Granular micronutrients were side-banded. Liquid micronutrients were used as foliar applications. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean, CDC Expresso black bean and AC Skipper navy bean were row crop seeded at a target plant population of 30 seeds/m^2 (105, 42 and 60 lb/ac, respectively) using a 60 cm (24 in) row spacing. The trial utilized a factorial arrangement of the treatments in a randomized complete block design with four replicates. Each treatment measured 2.4 m x 6 m (8 ft x 24 ft).

Current soil test recommendations indicated the requirement for 20-25 lbs P_2O_5/ac and 3.5 -5.0 lbs/ac copper for both irrigated pea and dry bean. As well, there was a recommendation of 20-30 lbs N/ac for irrigated dry bean.

Table 4. Spring soil analysis: Irrigated pea and dry bean micronutrient fertilizer response trials.

Crop	Depth (in)	pH	1:2 E.C. dS/m	NO_3-N	P	K	SO_4-S	Cu	Mn	Zn	B	Fe
				lb/ac								
Pea	0 - 12	8.3	0.4	41	73	758	47	1.8	11	2.6	4.8	44
	12 - 24	8.4	0.5	65			79					
Dry Bean	0 - 12	8.4	0.4	19	74	920	31	1.8	49	4.3	4.3	36
	12 - 24	8.4	0.5	31			50					

[1]*CSIDC, Outlook*

Pea

There was no effect of the micronutrient applications on irrigated Carneval pea plant stand, seed weight or plant height (Table 5). As well, there was no effect on days to 10% flowering or maturity. All treatments flowered 56 days after seeding and reached maturity 90 days after seeding.

Pea yield was increased above that of the control with the application of foliar copper and both soil and foliar applied zinc. The lowest yield was obtained for the control treatment where no micronutrient fertilizer was applied. Current soil test guidelines indicated that copper was low on this particular site for irrigated pea. Growing season environmental conditions may play as important a role as soil available levels of the micronutrients when deciding when to apply micronutrient fertilizer. Monitoring of soil fertility through an adequate soil testing program is the best way to determine micronutrient fertilizer requirements.

Table 5. Yield response of irrigated Carneval pea to micronutrient fertilizers.

Treatment		Yield		Seed weight (mg)	Plant stand #/m²	Plant Height (cm)
Application	Nutrient	kg/ha	bu/ac			
Check		3925	58.3	192	79	54
Soil	Copper	3927	58.3	180	89	62
	Zinc	4668	69.3	196	91	62
	Boron	4224	62.7	189	79	60
Foliar	Copper	4673	69.4	203	87	49
	Zinc	4731	70.3	203	88	55
	Boron	3996	59.3	196	84	58
LSD (0.05)		589	NS[1]	NS	11	NS
CV %		11.1	11.1	6.2	14.7	12.2

[1]not significant

Dry Bean

There was no significant effect of the micronutrient applications on irrigated dry bean plant stand, yield, or plant height (Table 6). As well, there was no effect on days to 10% flowering or maturity. All treatments flowered 53, 62 and 64 days after seeding. All three market classes of dry bean were affected by frost damage prior to reaching maturity. Variety differences were consistent with results from variety evaluation trials.

Current soil test guidelines indicated that copper was low on this particular site for irrigated dry bean. However, there was no response to copper fertilization. Yields were limited by the cool growing conditions in 1999 as well as by an early fall frost prior to maturity for all three market classes of dry bean. Monitoring of soil fertility through an adequate soil testing program is the best way to determine micronutrient fertilizer requirements.

Table 6. Micronutrient source and application effects on yield of three market classes of dry bean grown under irrigation.

	Yield						Seed weight (mg)			Plant stand (#/m²)		
	Othello		Expresso		Skipper							
Treatment	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	Othello	Expresso	Skipper	Othello	Expresso	Skipper
Control	1146	1021	366	326	280	249	287	156	158	24	25	22
Soil Cu	985	878	283	252	434	387	275	145	166	22	18	24
Soil Zn	1202	1071	288	257	533	475	292	155	144	26	18	24
Soil B	979	872	441	393	384	342	261	162	138	24	24	25
Foliar Cu	1049	935	163	145	379	338	291	149	156	25	19	20
Foliar Zn	1027	915	137	122	384	342	253	166	159	27	21	25
Foliar B	1121	999	157	140	296	264	273	157	156	25	19	21
Mean	1073	956	262	233	384	342	276	156	154	25	21	23
Factorial LSD (0.05)												
			kg/ha		bu/ac							
Variety (V)			162		144			6			3	
Treatment (T)			NS[1]		NS			NS			NS	
V x T			NS		NS			27			NS	
CV %			27.8					7.0			17.2	

[1]not significant

Evaluation of Inoculant Formulations in Combination with Nitrogen Fertilizer Applications for Irrigated Pea and Dry Bean

T. Hogg[1], M. Pederson[1], F. Walley[2]

Funded by the Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year three of five*

***Objective:** To evaluate the efficacy of granular legume inoculant as compared to the more traditional peat and liquid formulations in combination with nitrogen fertilizer.*

Nitrogen requirements of pulse crops are met through soil available nitrogen, fertilizer nitrogen applications and nitrogen fixation. The requirement for nitrogen fertilization depends on the level of soil available nitrogen and the ability of the pulse crop to fix nitrogen. Nitrogen fixation varies among the pulse crops. Generally, pea can fix large amounts of nitrogen while dry bean is considered to be less adept at nitrogen fixation and receives higher soil test recommendations.

Legume inoculants, which contain *Rhizobium* bacteria, are generally applied to the seed coat at seeding to help enhance nitrogen fixation. Inoculants are typically applied as peat based powders or as liquid formulations. Recently, manufacturers have begun to develop and formulate *Rhizobium* inoculants in granular form. Granular inoculant can be applied to the soil in the same manner that fertilizer can be applied before or during the seeding operation. Initial results with dry bean inoculants have indicated better nitrogen fixation and higher yields for the granular formulation applied in the seed row as compared to the peat based formulation. Further work is required to determine application strategies for granular inoculants.

An inoculant evaluation trial was established in the spring of 1999 at the CSIDC. A separate trial was used for each crop. Treatments included one each of liquid, peat and granular based inoculants, an uninoculated control and a flax control for determining nitrogen fixation in combination with four nitrogen fertilizer rates (0, 25, 50 and 75 kg N/ha; 0, 22, 44 and 66 lb N/ac). Liphatec was the inoculant source used in the study. Urea (46-0-0) was the nitrogen fertilizer source. The liquid and peat based inoculants were applied to the seed just prior to seeding. The granular inoculant was seed placed during the seeding operation. All plots received a side band application of a 10-41-12 blend at a rate of 120 kg/ha (107 lb/ac) during the seeding operation in addition to the nitrogen fertilizer application. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean was row crop seeded at a target plant population of 30 seeds/m^2 (105 lb/ac) using a 60 cm (24 in) row spacing. A factorial arrangement of the treatments in a randomized complete block design with four replicates was used for the trial. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft). Individual treatments were spaced on 3 m (10 ft) centers.

Current soil test recommendations indicated a requirement for 20 - 25 lbs P_2O_5/ac for pea and dry bean grown under irrigated conditions. As well, there was a recommendation of 25-35 lbs N/ac for irrigated dry bean (Table 7).

Table 7. Spring soil analysis: Pea and dry bean inoculant formulation evaluation trial.

Crop	Depth (in)	pH	1:2 E.C. dS/m	NO_3-N	P	K	SO_4-S
				lb/ac			
Pea	0 - 12	8.4	0.4	29	75	709	35
	12 - 24	8.4	0.5	37			73
Dry Bean	0 - 12	8.3	0.2	18	63	820	36
	12 - 24	8.5	0.5	29			66

Pea

There was no effect of inoculant formulation or nitrogen rate on irrigated Carneval pea yield, seed weight or plant height (Table 8). Nodule rating was significantly higher for the granular formulation than the peat formulation and the check treatment. However, there was no significant difference in nitrogen fixation, based on ^{15}N natural abundance measurements, for the different inoculant formulations (Table 10). As well, there was no effect of the inoculant formulations or nitrogen rates on days to 10% flowering or to maturity. All treatments flowered 57 days after seeding and reached maturity 95 days after seeding.

Table 8. Agronomic data for the irrigated Carneval pea inoculant formulation evaluation x nitrogen rate trial.

	Yield (kg/ha)					Seed weight (mg)					Plant height (cm)					Nodule rating[1]				
	Nitrogen rate					Nitrogen rate					Nitrogen rate					Nitrogen rate				
Formulation	0	25	50	75	Mean	0	25	50	75	Mean	0	25	50	75	Mean	0	25	50	75	Mean
Check	3109	3428	3971	3587	3524	221	214	211	205	213	68	77	76	79	75	5.8	5.8	4.8	5.3	5.4
Liquid	3944	4319	3506	3242	3753	222	212	210	216	215	73	78	79	78	77	5.5	5.8	5.8	5.5	5.6
Peat	3726	3420	3252	3283	3420	216	224	224	219	221	78	71	70	75	74	5.5	4.8	5.0	4.8	5.0
Granular	3375	3031	3865	3285	3389	221	220	219	217	219	75	69	80	78	75	7.0	7.3	5.5	6.0	6.4
Mean	3539	3549	3648	3349		220	218	216	214		74	74	76	77		5.9	5.9	5.3	5.4	
Anova LSD (0.05)																				
Inoculant (I)	NS[2]					NS					NS					0.9				
N rate (N)	NS					NS					NS					NS				
I x N	NS					NS					NS					NS				
CV %	19.4					4.7					10.5					22.2				

[1]0 = no N-fixation potential: 8 = fully effective nodulation
[2]not significant

Table 9. Agronomic data for the irrigated Othello pinto bean inoculant formulation evaluation x nitrogen rate trial.																				
	Yield (kg/ha)					Seed weight (mg)					Plant height (cm)					Nodule rating[1]				
	Nitrogen rate					Nitrogen rate					Nitrogen rate					Nitrogen rate (kg/ha)				
Formulation	0	25	50	75	Mean	0	25	50	75	Mean	0	25	50	75	Mean	0	25	50	75	Mean
Check	1469	1131	1381	1426	1352	285	278	280	271	279	44	49	46	50	47	7.3	7.0	6.5	6.0	6.7
Liquid	1228	1388	1183	1240	1260	275	281	264	277	274	44	44	48	43	45	7.0	7.0	6.5	7.0	6.9
Peat	1207	1140	1297	1335	1245	273	282	285	273	278	44	46	47	45	46	7.0	6.5	7.3	6.8	6.9
Granular	1317	1318	1356	1274	1316	282	289	280	274	281	45	47	45	49	47	7.0	7.3	7.3	7.3	7.2
Mean	1305	1244	1304	1319		279	283	277	274		44	46	46	47		7.1	6.9	6.9	6.9	
Anova																				
LSD (0.05)																				
Inoculant (I)	NS[2]					NS					NS					NS				
N rate (N)	NS					NS					NS					NS				
I x N	NS					NS					NS					NS				
CV %	16.6					3.3					9.5					8.3				

[1]0 = no N-fixation potential: 8 = fully effective nodulation
[2]not significant

Dry Bean

There was no effect of inoculant formulation or nitrogen rate on irrigated Ohtello pinto bean yield, seed weight, plant height or nodule rating (Table 9). Cool growing season conditions experienced in 1999 and an early fall frost were probably responsible for reduced dry bean yield and may have masked any response to the inoculant formulation and nitrogen rate treatments. Nitrogen fixation for the different inoculant formulations, based on ^{15}N natural abundance measurements, indicated the granular formulation was significantly greater than the liquid formulation which was greater than the peat formulation and the control treatment (Table 10). The granular formulation would appear to be superior to the other inoculant formulations for dry bean. There was no effect on days to 10% flowering or maturity. All treatments flowered 64 days after seeding and reached maturity 111 days after seeding.

Table10. Nitrogen fixation for the inoculant formulation trial.		
	%Ndfa[1]	
Inoculant	Pea	Dry Bean
Control	37.0	29.2
Liquid	40.2	45.3
Peat	37.5	33.3
Granular	38.3	53.0
LSD (0.05)	NS[2]	13.9
CV (%)	21.7	21.7

[1]Nitrogen derived from the atmosphere based on ^{15}N natural abundance
[2]not significant

Seeding Rate and Row Spacing Effects on Irrigated Dry Bean

T. Hogg[1], M. Pederson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year three of five*

***Objective:** To demonstrate the effect of seeding rate and row spacing on the yield of different dry bean market classes under irrigated conditions.*

Seed yield of dry bean generally increases as plant density increases. High plant density is often associated with low aeration, high humidity and prolonged periods of dampness that can result in the development of white mold (*Sclerotinia*). These factors will be affected by both plant architecture and row spacing. The currently recommended seeding rate for irrigated production of dry bean is in the range of 25-30 seeds/m^2 using a row spacing ranging from 60-80 cm (24-32 in). Preliminary results from work conducted at the CSIDC indicate an optimum seeding rate of 20 seeds/m^2 with small variations among the different market classes. Lower seeding rates would reduce the seeding costs for producers. Further work is required to verify these results.

A dry bean seeding rate x row spacing trial was established in the spring of 1999 at the CSIDC. A separate trial was established for each of pinto, black and navy dry bean market classes. Treatments consisted of three seeding rates, three row spacings (20, 60 and 80 cm; 8, 24 and 32 in) and two varieties for each dry bean market class (Table 11). Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. The treatments were arranged in a strip-split-plot design. Varieties and seeding rate treatments were randomized within the row spacing strips. All treatments were replicated four times. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft).

Table 11. Seeding rates for varieties sown in the irrigated dry bean seed rate x row spacing trial.

Market Class	Variety	Plant type	Seeds/m^2 20	25	30
			Seeding rate (lb/ac)		
Pinto	Othello	Type III indeterminate vine	69	87	104
	CDC Camino	Type I upright determinate	64	80	96
Black	UI 906	Type I upright determinate	31	39	47
	CDC Expresso	Type I upright determinate	28	35	42
Navy	Seafarer	Type I determinate bush	40	50	60
	AC Skipper	Type I upright determinate	34	42	51

[1]*CSIDC, Outlook*

Plant stand increased as the seeding rate was increased and decreased as the row spacing increased from 20 cm to 60 cm for all three market classes of dry bean (Figure 1-3). This probably occurred due to closer spacing between plants within a row causing increased plant competition.

There were no observed effects of seeding rate or row spacing on days to 10% flowering for the pinto, black or navy dry bean. Maturity was affected by both a cool growing season and an early fall frost (September 13) which reduced yield potential. As well, there was considerable white mold (Sclerotinia) present late in the growing season, probably a result of the cool moist growing conditions.

Yield effects varied among the market classes and varieties within a market class. Pinto bean showed no effects of seeding rate, row spacing or variety on yield (Table 12). For black bean yield was significantly higher for the 80 cm row spacing than either the 20 or 60 cm row spacings (Table 13). UI 906 produced a higher yield than Expresso due to a greater number of seeds and not due to a higher seed weight. The later maturing navy bean, in comparison to the pinto and black bean, was affected to a greater extent by the early fall frost. For navy bean only AC Skipper was harvested. For AC Skipper navy bean there was a significant seeding rate by row spacing interaction effect on yield. Highest yield was obtained for the 30 seeds/m² seeding rate at the 60 cm row spacing (Table 14). The cool growing season conditions and early fall frost experienced in 1999 probably had an overriding effect on the yields of all dry bean market classes.

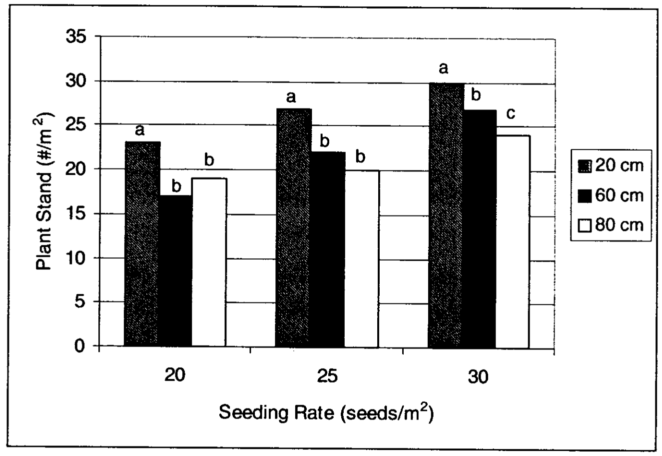


Figure 1. Seeding rate and row spacing effects on plant stand of irrigated pinto bean (row spacings within a seeding rate with the same letter are not significantly different at p = 0.05).

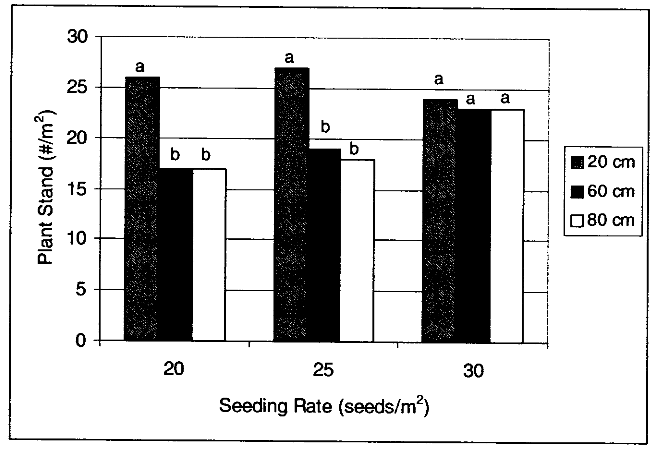


Figure 2. Seeding rate and row spacing effects on plant stand of irrigated black bean (row spacings within a seeding rate with the same letter are not significantly different at p = 0.05).

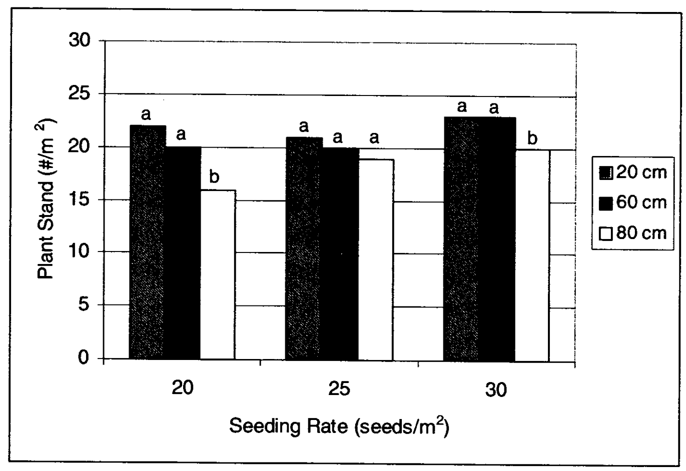


Figure 3. Seeding rate and row spacing effects on plant stand of irrigated AC Skipper navy bean (row spacings within a seeding rate with the same letter are not significantly different at p = 0.05).

Table 12. Seeding rate and row spacing effect on yield of Othello and CDC Camino pinto bean grown under irrigation.

Seed rate (#/m2)	Yield (kg/ha)						Mean
	20 cm		60 cm		80 cm		
	Othello	Camino	Othello	Camino	Othello	Camino	
20	817	859	986	875	1029	871	906
25	923	945	878	878	1069	1022	953
30	847	916	1093	866	1051	920	932
Mean	868		929		994		

ANOVA LSD (0.05)

ANOVA LSD (0.05)		Variety	Mean
Row spacing (RS)	NS[1]		
Seed rate (SR)	NS		
RS x SR	NS	Othello	966
Variety (V)	68		
RS x V	NS	CDC Camino	895
SR x V	NS		
RS x SR x V	NS		
CV (%)	15.2		

[1]not significant

Table 13. Seeding rate and row spacing effect on yield of CDC Expresso and UI 906 black bean grown under irrigation.

Seed rate (#/m2)	Yield (kg/ha)						Mean
	20 cm		60 cm		80 cm		
	Othello	Camino	Othello	Camino	Othello	Camino	
20	847	871	858	858	826	1296	926
25	829	882	926	999	1018	1345	100
30	893	805	919	1004	1204	1324	1025
Mean	855		927		1169		

ANOVA LSD (0.05)		Variety	Mean
Row spacing (RS)	89		
Seed rate (SR)	NS[1]		
RS x SR	NS	CDC Expresso	925
Variety (V)	99		
RS x V	171	UI 906	1043
SR x V	NS		
RS x SR x V	NS		
CV (%)	16.2		

[1]not significant

Table 14. Seeding rate and row spacing effect on yield of AC Skipper navy bean grown under irrigation.

Seed rate (#/m2)	Yield (kg/ha)			Mean
	20 cm	60 cm	80 cm	
20	692	645	610	649
25	621	721	715	686
30	612	743	641	665
Mean	642	703	655	

ANOVA LSD (0.05)	
Row spacing (RS)	NS[1]
Seed rate (SR)	NS
RS x SR	99
CV (%)	10.1

[1]not significant

Foliar Disease Management in Field Pea, Lentil and Chickpea

T. Hogg[1], M. Pederson[1], L. Buchwaldt[2]

Funded by the Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year one of two*

Objective: *To demonstrate the efficacy of foliar fungicides for controlling disease in pulse crops.*

Foliar diseases, such as anthracnose and ascochyta can cause substantial losses in seed yield and quality of pulse crops. When anthracnose and ascochyta are developing rapidly, timely application of fungicide may reduce losses and increase net income. However, if disease development is limited by unfavourable weather or other factors, fungicide application isn't always cost-effective. The objective of this work is to determine the merits of using a foliar fungicide for controlling diseases in field pea, lentil and chickpea and to aid in the development of a decision support system to assess disease risk and evaluate the need for fungicide application.

Fungicide application had a significant effect on the yield of all three pulse crops (Tables 15-17). Quadris applied at early flower for pea and mid-flower for lentil and chickpea as well as Bravo Ultrex applied at early flower for lentil produced significantly higher yield than the other treatments.

Pea and lentil seed weight showed no effect of fungicide application. For chickpea fungicide application increased seed weight for the Quadris applied at mid-flower compared to Quadris and Bravo Ultrex applied at early flower. The greatest increase in seed weight with fungicide application was observed for Sanford chickpea.

[1]*CSIDC, Outlook*
[2]*Agriculture and Agri-Food Canada Research Centre, Saskatoon*

Disease pressure (% ascochyta) for all three pulse crops was minimal early in the growing season but increased substantially later in the growing season (Table 18). Disease incidence was significantly reduced for the Quadris applied at mid-flower on the chickpea. Fungicide application did not significantly affect disease incidence for pea or lentil. Visible differences were quite evident among the fungicide treatments applied to the Sanford chickpea as the growing season progressed towards plant maturity. Visible disease differences among the fungicide treatments were less evident for the pea and lentil.

Table 15. Agronomic data for the irrigated pea foliar disease managment trial.

Treatment	Growth stage	Yield (kg/ha)			Seed weight (mg)			Plant stand (#/m²)		
		Grande	Carneval	Mean	Grande	Carneval	Mean	Grande	Carneval	Mean
Check		3609	4363	3986	182	183	182	43	56	50
Quadris	10% flower	3851	4932	4391	178	195	187	44	49	46
Quadris	10 - 14 days after 10% flower	3907	3904	3905	191	193	192	47	57	52
Bravo Ultrex	10% flower	3458	4511	3984	182	184	183	42	54	48
Mean		3706	4427		183	189		44	54	
ANOVA LSD (0.05)										
Cultivar (C)			703			NS[1]			5	
Treatment (T)			303			NS			NS	
C x T			428			NS			NS	
CV (%)			7.1			4.6			18	

[1]not significant

Table16. Agronomic data for the irrigated lentil foliar disease managment trial.

Treatment	Growth stage	Yield (kg/ha)			Seed weight (mg)			Plant stand (#/m²)		
		Redwing	Richlea	Mean	Redwing	Richlea	Mean	Redwing	Richlea	Mean
Check		1968	2667	2318	52	33	43	77	84	80
Quadris	10% flower	1834	2563	2198	55	33	44	95	85	90
Quadris	10 - 14 days after 10% flower	2016	3113	2565	56	33	44	84	82	83
Bravo Ultrex	10% flower	2275	2852	2564	54	33	44	67	85	76
Mean		2023	2799		54	33		81	84	
ANOVA LSD (0.05)										
Cultivar (C)			555			3			NS	
Treatment (T)			240			NS			NS	
C x T			NS[1]			NS			NS	
CV (%)			9.5			3.2			38.5	

[1]not significant

Table17. Agronomic data for the irrigated chickpea foliar disease managment trial.										
		Yield (kg/ha)			Seed weight (mg)			Plant stand (#/m^2)		
Treatment	Growth stage	Sanford	Myles	Mean	Sanford	Myles	Mean	Sanford	Myles	Mean
Check		0	1611	805	---	---	---	50	47	49
Quadris	10% flower	178	1657	917	128	146	140	52	49	51
Quadris	10 - 14 days after 10% flower	840	2513	1677	234	153	194	51	47	49
Bravo Ultrex	10% flower	281	1545	913	163	139	149	45	50	47
Mean		325	1831		187	146		49	48	
ANOVA LSD (0.05)										
Cultivar (C)		587			22			NS		
Treatment (T)		413			8			NS		
C x T		NS[1]			12			NS		
CV (%)		36.5			4.5			17.8		

[1]not significant

Table18. Disease ratings for the pulse crop foliar disease managment trial.										
		Pea: % Ascochyta			Lentil: % Ascochyta & Anthracnose			Chickpea: % Ascochyta		
Treatment	Growth stage	Early flower	Mid flower	3 - 4 weeks	Early flower	Mid flower	3 - 4 weeks	Early flower	Mid flower	3 - 4 weeks
Check		6	12	85	<1	<1	75	<1	<1	85
Quadris	10% flower	6	14	77	<1	<1	76	<1	<1	70
Quadris	10 - 14 days after 10% flower	5	12	81	<1	<1	51	<1	<1	50
Bravo Ultrex	10% flower	7	5	78	<1	<1	48	<1	<1	75
LSD (0.05)		NS[1]	NS	NS	NS	NS	NS	NS	NS	20

[1]not significant

Time of Weed Removal in Field Pea

T. Hogg[1], M. Pederson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year one of two*

Objective: *To evaluate the concept of time of weed removal in field pea as developed by Dr. George Clayton and Dr. Neil Harker of the Lacombe Research Centre on a more extensive basis.*

Field Peas require adequate weed removal to maintain optimum yield and quality. Dr. George Clayton and Dr. Neil Harker of the Lacombe Research Centre have shown that significant yield losses may be experienced when weed removal is delayed in field pea. Post-Emergent herbicides can be used to decrease weed populations in field peas. Information on timing of applications is required by producers in order to best maximize their returns.

Yield was significantly affected by the delay in post-emergent herbicide application and Grande pea had a higher yield than Carneval pea (Table 19). The 1 WAE and 2 WAE herbicide application times had significantly higher yield than the 3 WAE herbicide application time and the check. Significant yield loss of irrigated pea resulted with a delay in weed removal, confirming the importance of early weed removal in pea production.

Seed weight was also significantly affected by the time of post-emergent herbicide application. Seed weight decreased as the time of herbicide application was delayed (Table 19). The 1 WAE herbicide application time had a significantly higher seed weight than the other treatments.

Table 19. Agronomic data for the irrigated pea time of weed removal trial.

Treatment	Yield (kg/ha)			Seed weight (mg)			Plant height (cm)		
	Grande	Carneval	Mean	Grande	Carneval	Mean	Grande	Carneval	Mean
Check	2323	2137	2230	199	196	197	102	94	98
1 WAE[1]	3616	3431	3523	239	239	239	84	79	82
2 WAE	3599	3050	3325	214	211	212	80	81	80
3 WAE	2404	2300	2352	209	202	206	68	82	75
Mean	2986	2729		215	212		83	84	
LSD (0.05)									
Cultivar (C)	250			NS			NS		
Treatment (T)	353			20			10		
C x T	NS[2]			NS			NS		
CV (%)	11.9			9.2			11.9		

[1]weeks after emergence
[2]not significant

Plant height was greater for the check treatment (Table 19). Time of herbicide application had no significant effect on plant height. This would suggest a stunting effect by the herbicide application, probably caused by a shortening of the inter-node length.

All treatments had high weed populations prior to post-emergent herbicide application (Table 20). The most prevalent weeds present were wild buckwheat, wild millet and redroot pigweed.

[1]*CSIDC, Outlook*

Herbicide efficacy, as indicated by the visual ratings at 14 and 28 days after herbicide application, very clearly indicates that the early application of the post-emergent herbicide produced more effective weed control (Table 20). Observations at 14 days after herbicide application indicated that the 1 WAE herbicide application time had excellent weed control. For the 2 WAE herbicide application time, the crop canopy had started to close in resulting in prevention of proper herbicide penetration and thus somewhat poorer weed control. For the 3 WAE herbicide application time, weed control was very poor. Observations at 28 days after herbicide application indicated that there was still excellent weed control for the 1 WAE herbicide application time. For the 2 WAE herbicide application, time there was some regrowth of weeds while for the 3 WAE herbicide application time there was poor weed control.

Table20. Weed data for the irrigated pea time of weed removal trial.

	Broadleaf weeds (#/m²)			Grassy weeds (#/m²)			Visual rating 14 DAA[1]			Visual rating 28 DAA		
Treatment	Grande	Carneval	Mean	Grande	Carneval	Mean	Grande	Carneval	Mean	Grande	Carneval	Mean
Check	65	52	59	21	17	19	0	0	0	0	0	0
1 WAE[2]	62	53	57	14	17	16	95	96	96	95	96	96
2 WAE	49	46	47	35	24	30	74	73	74	74	73	74
3 WAE	60	73	67	18	25	22	30	30	30	0	0	0
Mean	59	56		22	21		50	50		42	42	
LSD (0.05)												
Cultivar (C)	NS[3]			NS			NS			NS		
Treatment (T)	NS			8			2			2		
C x T	NS			NS			NS			NS		
CV (%)	29.6			35.7			4.3			5.0		

[1]Days after application
[2]weeks after emergence
[3]not significant

Efficacy of Four Chemical Seed Treatments Against Surface-Borne Halo and Common Blight Bacteria on Dry Edible Bean

T. Hogg[1], M. Pederson[1], R. Howard[2], D. Burke[2], S. Huggons[2]

***Progress:** Year two of two*

***Objective:** To determine the efficacy of alternative seed treatments as compared to streptomycin for the control of halo blight and common blight on dry edible bean.*

For the past decade, Canadian dry bean growers have relied upon Streptomycin as the only treatment to control surface-borne bacterial blight pathogens on seed. In 1997, the Pest Management Regulatory Agency (PMRA) of Health Canada notified the bean industry stakeholders that it would no longer permit the importation of bean seed pre-treated with streptomycin because of unresolved questions about possible adverse health effects caused by human pathogens resistant to this antibiotic. In 1998, with the support of producer associations, chemical companies and other stakeholder groups, a two-year study was initiated to find and register an inexpensive and effective replacement for streptomycin that could be applied to domestically produced and imported bean seed destined for planting in Canada.

[1]*CSIDC, Outlook*
[2]*Alberta Agriculture, Food and Rural Development, Crop Diversification Centre-South, Brooks, Alberta*

Trials in 1998 focused on evaluating the performance of seven inorganic bactericidal seed treatments and, based on this work, Zineb 80WP and Bluestone (copper sulphate) were chosen for further testing in 1999. In the spring of 1999 a trial was established at the CSIDC. Zineb 80WP and Bluestone were applied at two rates (1.5 and 2.0 g/kg seed) on NW63 (small red) and Viva (pink) bean seed that had been artificially infested with halo blight and common blight bacteria. Zineb, Bluestone and Streptomycin were applied in combiation with the fungicide Vitaflo-280, which served as a carrier for these wettable powder and granular products. These mixtures were compared to Vitaflo-280 alone and an untreated check. Peat based inoculant was applied to the seed just prior to seeding. The treatments were arranged in a randomized complete block design with five replications. Each treatment consisted of four 6 m (20 ft) rows, with a 60 cm (24 in) row spacing planted at a rate of 120 seeds/m row (30 seeds/ft). Rows were trimmed to 5 m (16 ft) length after plant emergence. Separate trials were conducted for the two dry bean varieties. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed.

Both trials showed a high incidence (ca. 100%) of halo and common blight on the plants in each treatment. The four inorganic bactericide treatments did not significantly reduce the incidence or severity of bacterial blight, nor did they significantly increase the emergence when compared to Vitaflo-280 alone, Agricultural Streptomycin or the untreated check (Tables 21 and 22). However, in NW63, the inorganic bactericide treatments yielded 14% more, on average, than Agricultural Streptomycin. None of the chemical treatments appeared to have any significant phytotoxic effects as reflected by emergence and yield data.

Table 21. The effect of four fungicidal/bactericidal seed treatments on seedling emergence, disease severity, and seed yield of irrigated NW63 dry bean.

Treatment	Rate of product/ kg seed	Emergence (%)	Disease severity (0 - 4)[1]	Yield (kg/ha)
Zineb 80WP + Vitaflo 280	1.5 g + 2.6 ml	78.2	2.9	1915 ab
Zineb 80WP + Vitaflo 280	2.0 g + 2.6 ml	77.8	3.0	2054 ab
Bluestone + Vitaflo 280	1.5 g + 2.6 ml	77.6	3.0	1944 ab
Bluestone + Vitaflo 280	2.0 g + 2.6 ml	82.0	3.3	2099 a
Vitaflo 280	2.6 ml	77.4	3.1	1942 ab
Ag. Streptomycin + Vitaflo 280	1.0 g + 2.6ml	79.2	3.2	1755 c
Untreated check	---	78.4	3.0	1966 ab
ANOVA (P<0.05)		0.629	0.077	0.006
LSD (P=0.05)		---	---	159.76
CV (%)		5.29	6.44	6.26

[1]Severity rating: 0 = no disease; 1 = slight (1 - 10% leaf area blighted); 2 = moderate (11 - 25% blighted); 3 = severe (26 - 50% blighted); 4 = very severe (>50% blighted)

Values in the above tables are means of five replications. Numbers within a column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (P<0.05).

Table 22. The effect of four fungicidal/bactericidal seed treatments on seedling emergence, disease severity, and seed yield of irrigated Viva dry bean.

Treatment	Rate of product/ kg seed	Emergence (%)	Disease severity (0 - 4)[1]	Yield (kg/ha)
Zineb 80WP + Vitaflo 280	1.5 g + 2.6 ml	84.8	2.9	2574
Zineb 80WP + Vitaflo 280	2.0 g + 2.6 ml	82.2	3.0	2562
Bluestone + Vitaflo 280	1.5 g + 2.6 ml	---	---	---
Bluestone + Vitaflo 280	2.0 g + 2.6 ml	81.2	3.0	2344
Vitaflo 280	2.6 ml	84.6	3.1	2603
Ag. Streptomycin + Vitaflo 280	1.0 g + 2.6ml	80.8	3.0	2512
Untreated check	---	84.2	2.9	2650
ANOVA (P<0.05)		0.08	0.925	0.482
CV (%)		3.15	8.03	9.75

[1]Severity rating: 0 = no disease; 1 = slight (1 - 10% leaf area blighted); 2 = moderate (11 - 25% blighted); 3 = severe (26 - 50% blighted); 4 = very severe (>50% blighted)

Values in the above tables are means of five replications. Numbers within a column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (P<0.05).

Varietal Investigations

Prairie Regional Dry Bean Wide-Row Co-operative Test

T. Hogg[1], M. Pederson[1], H. Mundel[2], J. Braun[2]

Progress: *Ongoing*

Location: *Outlook*

Objective: *To evaluate new dry bean germplasm for irrigation under wide-row cropping conditions for western Canada.*

This project evaluates dry bean germplasm for its adaptation to Western Canada under irrigated row crop conditions. The germplasm sources include advanced lines from the Agriculture and Agri-Food Canada Lethbridge Research Centre and from the Crop Development Centre, University of Saskatchewan. These lines are compared to a standard registered variety within each market class.

An irrigated site was conducted at the CSIDC. Standard fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. All entries were row crop seeded using a 60 cm (24 in) row spacing. The test consisted of 25 entries in a 5 x 5 lattice design and included five bean types (pinto, pink, small red, great northern and black). Ten test entries were in the second year of co-op testing (Black: L95F025, L96F101; Great Northern: L96E108; Pink : L94C333LE, L96C104; Pinto: 64-68-8, 95-82-13-PT; Small Red: L94D247LE, L96D104, L96D116). The rest were new to the test. Individual plots consisted of two rows with 60 cm (24 in) row spacings and measured 1.2 m x 3.7 m (4 ft x 12 ft). All rows of a plot were harvested to determine yield.

The cool growing season conditions and early fall frost experienced in 1999 were not favourable for bean production and as a result yields were lower than normal (Table 23). The highest overall yield was obtained for the small red varieties AC Earlired, L97D263 and L94D247LE. None of the new small red lines from Lethbridge exceeded AC Earlired in yield. The pink variety AC Alberta Pink and the pinto variety 64-68-8 produced yields slightly higher than Othello. Several of the other varieties produced very low yields. Days to maturity for all entries was about 10 days later than in 1998. The black entries L96F101 and 316-12 exceeded the black check UI906 for yield at equal maturity but overall were low yielding compared to the other entries.

[1]*CSIDC, Outlook*
[2]*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge*

Table 23. Yield and agronomic data for the irrigated dry bean wide-row co-operative test.

Variety	Yield (kg/ha)	Yield % of check	Lodging 1 = erect 5 = flat	Vine length (cm)	Days to 50% flower[1]	Days to maturity[2]	Seed weight (mg)
Pinto							
Othello (check)	1392	100	2.3	50	63	118	298
64-68-8	1410	101	2.8	48	66	119	253
95-82-13-PT	1315	95	2.5	54	63	120	270
L97B255	827	59	1.8	44	62	118	230
Pink							
Viva (check)	1161	100	2.5	45	62	118	202
AC Alberta Pink	1428	123	3.3	47	64	118	230
L94C333LE	902	78	2.0	46	64	120	233
L96C104	1251	108	2.0	47	63	115	311
Small Red							
NW63 (check)	999	100	2.0	47	60	118	238
AC Earlired	1574	158	2.3	44	65	115	249
L94D247LE	1496	150	2.5	41	64	113	244
L96D104	1241	124	2.0	46	63	114	260
L96D116	1345	135	2.3	45	61	118	258
L97D228	1274	128	2.0	49	62	118	267
L97D252	1197	120	2.0	50	62	118	318
L97D256	1245	125	2.0	44	63	119	239
L97D263	1558	156	2.0	47	62	119	277
L97D266	1346	135	1.8	46	62	119	269
L97D273	1311	131	1.5	51	65	119	259
Black							
UI 906 (check)	681	100	1.8	42	67	120	133
316-12	959	141	1.5	51	65	121	165
L95F025	510	75	2.0	43	68	118	154
L96F101	985	145	2.0	41	61	120	225
Great Northern							
US1140 (check)	895	100	1.8	43	63	121	248
L96E108	1163	130	2.3	61	64	121	207

[1]50% of plants/plot have open flowers
[2]50% of pods are buckskin colored

Prairie Regional Dry Bean Narrow-Row Co-operative Test

A. Vandenberg[1], T. Hogg[2], M. Pederson[2]

Funded by the Crop Development Centre, U of S, Saskatoon, Saskatchewan

Progress: *Ongoing*

Location: *Outlook*

Objective: *To evaluate new dry bean germplasm for irrigation under narrow-row cropping conditions for western Canada.*

This project evaluates dry bean germplasm for solid seeded growing conditions in western Canada. The germplasm sources include advanced lines of entries from the Agriculture and Agri-Food Canada Lethbridge Research Centre and from the Crop Development Centre, University of Saskatchewan. These lines are compared to a standard registered variety within each market class.

The 1999 trial was split into an "A" trial with 12 black and navy entries and a "B" trial with 36 entries for other market classes (pinto, great northern, pink, small red and Flor de Mayo). All entries were replicated three times. An irrigated site was conducted at CSIDC. Standard fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. All entries were seeded using a 30 cm (12 in) row spacing. A check variety was included for each market class. For the pinto and great northern market classes, both Type I and Type III checks were included. Individual plots measured 1.2 m x 3.7 m (4 ft x 12 ft). All rows of a plot were harvested to determine yield.

Test A yield data were not included due to high CV related to frost damage in the fall. All new black entries had better pod clearance than the check varieties (Table 24). Black entries flowered as early as or earlier than the check varieties but tended to mature later. The one new navy entry flowered later than the check variety and matured later.

Overall, yields for Test B were low, probably a result of the cool growing conditions and the early fall frost experienced in 1999 (Table 25). New entries with high yield potential included 95-83-10 and 354b-14 Pinto, L95E101, L96E108 and 2576-6 Great Northern, CDC Rosalee and 284-25 Pink and L97D223 Small Red. Days to flower for the new entries were similar to the check varieties, however, some of the new entries showed reduced days to maturity.

Table 24. Agronomic data for the Praire Dry Bean narrow-row co-operative trial A.

Variety	Vine length (cm)	Days to 50% flower[1]	Days to maturity[2]	Pod clearance rating (%)[3]
Black				
CDC Nighthawk (check)	39	62	116	41
UI 906 (check)	42	64	111	42
L95F025	48	67	117	63
L96F101	38	59	113	55
321-9	40	60	120	52
318-34	31	59	116	52
315-18	48	63	121	81
320-6	44	66	121	56
316-13	42	60	117	57
318-64	44	62	121	71
Navy				
AC Skipper (check)	36	62	119	54
Minerva	34	70	121	21
Mean	41	63	118	54
CV (%)	7.5	4.3	2.8	24.5

[1]50% of plants/plot have open flowers
[2]50% of pods are buckskin colored
[3]% of pods > 5cm (2 in) above ground surface

[1]*Crop Development Centre, U of S, Saskatoon, Saskatchewan*
[2]*CSIDC, Outlook*

Table 25. Yield and agronomic data for the Prairie Dry Bean narrow-row co-operative trial B.

Variety	Yield (kg/ha)	Yield % of check	Vine length (cm)	Days to 50% flower[1]	Days to maturity[2]
Pinto					
Othello (check)	1179	100	42	62	117
CDC Camino (check)	1208	102	41	61	115
95-6-1	1243	105	39	61	115
95-65-6	1119	95	43	62	114
L96B101	1163	99	45	62	115
95-83-10	1327	113	42	61	116
93-122-10	1064	90	43	61	114
L97B231	1029	87	42	58	114
L95B165	1246	106	43	59	116
354-14	1421	121	45	62	117
354-13	1259	107	37	62	111
351-26	940	80	44	61	115
CDC Pintium	1241	105	41	61	111
Great Northern					
US 1140 (check)	945	100	45	61	116
CDC Nordic (check)	1320	140	45	58	117
201-25LL	863	91	41	58	112
L95E101	1234	131	44	60	119
L96E108	1101	117	49	62	120
165-11	945	100	43	60	115
95-52-1	602	64	37	59	116
2576-6	1132	120	44	62	119
9674	980	104	40	62	116
Pink					
Viva (check)	1074	100	41	60	112
CDC Rosalee	1285	120	46	60	115
L97C203	1019	95	39	62	115
284-25	1255	117	41	61	105
95-19-4	1005	94	45	60	114
93175-4	910	85	45	60	116
Small Red					
NW63 (check)	1137	100	42	59	114
296-X-7	774	68	47	60	118
L96D112	1230	108	44	61	117
L96D113	1083	95	44	62	117
L97D223	1405	124	40	62	117
297-15	905	80	44	60	115
302-5	510	45	44	62	114
Flor de Mayo					
180-5	839		47	61	118
Mean	1083		43	61	115
CV (%)	20.8			3.0	3.5

[1]50% of plants/plot have open flowers
[2]50% of pods are buckskin colored

Irrigated Field Pea Variety Test

L. Townley-Smith[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

ICDC pea variety testing plots were grown at four locations in the Outlook area. Each site and soil type are as follows:

CSIDC: Bradwell very fine loam.
CSIDC offsite: Asquith sandy loam.
H. Jeske: Tuxford clay loam.
R. Pederson: Elstow loam.

Pea varieties were tested for their agronomic performance under irrigation. Plots were seeded at four sites and with four replicates at each site.

1.5 m x 4.0 m (5 ft x 13 ft) plots were sown May 18 to May 26. All plots received 50 kg/ha P (45 lb/ac) as 11-52-0 and were inoculated just prior to seeding. Harvest was taken August 30 to September 7. Yields were estimated by harvesting the entire plot. The results are presented inTable 26.

Table 26. Yield and agronomic data for the irrigated field pea variety test.

	Jeske site			Pederson site			Off-station site			CSIDC			Mean yield		
Variety	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	kg/ha	bu/ac	% of Radley
Radley	3817	95	8.7	1425	72	8.5	2556	66	8.8	2798	91	9	2649	39.2	100
4-0359.016	5420	107	5.7	4183	85	7	3527	66	7.8	5532	110	7.8	4666	69.0	176
AC Melfort	3961	91	8.7	2969	69	9	2140	63	8.5	4251	83	9	3330	49.2	126
CDC 9705	4863	106	8.3	3945	78	8	3578	70	8.5	5247	95	8	4408	65.2	166
CDC Vienna	3752	99	7.3	1380	85	8.5	2743	72	8.8	1445	97	7.5	2330	34.4	88
Highlight	4317	102	8.3	3253	81	8.3	3268	68	8.3	3233	81	9	3518	52.0	133
Princess	4584	107	7.3	2475	89	7.8	2560	76	7.3	2974	1022	7.8	3148	46.5	119
SW 93605	4548	108	7.3	3639	85	7.8	3263	70	8	5700	94	7.3	4288	63.4	162
Voyageur	4131	94	7.3	2703	73	8.3	2869	69	8.5	2937	95	7.8	3160	46.7	119

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Prairie Regional Pea Co-operative Test A, Test B, and Test C

T. Warkentin[1], A. Sloan[2], T. Hogg[3], M. Pederson[3]

Funded by the Crop Development Centre, U of S, Saskatoon, Saskatchewan

Progress: *Ongoing*

Objective: *To evaluate new pea germplasm for irrigation cropping conditions in western Canada.*

This project evaluates pea germplasm for growing conditions in western Canada. The germplasm sources include advanced lines from the Agriculture and Agri-Food Canada Morden Research Centre, the Crop Development Centre, University of Saskatchewan, and private seed companies. Entries were divided into three tests (A, B, C) with 31 candidate entries in Test A, 31 candidate entries in Test B and 12 candidate entries in Test C. Tests A and B had five checks and Test C had 4 checks. First year check cultivars were: Carrera, Carneval, CDC9705 (CDC Mozart) and Keoma; second year check cultivars were: Carrera, Carneval, Delta and Keoma. Relatively late maturing entries were placed in Test A.

An irrigated site was conducted at the CSIDC. Standard fertilizer, weed control and irrigation practices for irrigated pea production were followed. All three tests were arranged in a lattice design with three replicates. Individual plots measured 1.2 m x 3.7 m (4 ft x 12 ft). All rows of a plot were harvested to determine yield.

In Test A, four new yellow entries (Ceb1475, CDC9805, Ceb1484 and SW955180) and one green entry (Ceb1171) had yield greater than Carneval (Table 26). Most new green entries yielded higher than Keoma. The highest yielding entry (CDC9805) had a seed size similar to Carneval. Two new yellow entries (Ceb1466 and DS49376) showed similar or better lodging rating than Carneval but had lower yield potential. One green entry (Ceb1163) had superior lodging tolerance than Carneval, but had a low yield potential. All other green entries had relatively poor lodging tolerance compared to Carneval. The highest yielding varieties were just slightly later maturing than Carneval.

Test B was excluded due to high CV for yield.

In Test C, only one new entry yielded higher than Carneval (Table 27). Five new yellow entries showed similar or better lodging rating than Carneval but had lower yield potential. Yellow entry NSA93-0030-2 flowered and matured earlier than Carneval. Yellow entry NORD95/208 flowered 10 days earlier than Carneval. Four yellow entries and one green entry matured 4-6 days earlier than Carneval.

[1]*Crop Development Centre, U of S, Saskatoon, Saskatchewan*
[2]*Agriculture and Agri-Food Canada, Morden Research Centre, Morden*
[3]*CSIDC, Outlook*

Table 27. Yield and agronomic data for the irrigated Pea Co-operative test A.							
Variety	Yield (kg/ha)	Yield % of Carneval	Lodging 0 = erect 9 = flat	Vine length (cm)	Days to 10% flower[1]	Days to maturity[2]	Seed weight (mg)
Yellow							
Carrera	4345	98	9.0	71	62	103	228
Carneval	4418	100	7.0	85	65	103	193
CDC 9705	4114	93	9.0	72	65	103	223
Delta	3530	80	8.6	77	64	103	217
MP1803	3893	88	7.3	77	65	109	197
MP1805	4195	95	7.7	77	65	103	178
MP1804	3803	86	9.0	79	65	103	202
MP1806	3577	81	7.7	76	65	106	130
Alberta	3919	89	7.0	67	61	102	278
SW 94594	3988	90	8.0	87	64	103	218
Ceb 1466	4052	92	6.4	70	61	103	244
Ceb 1475	4845	110	8.0	81	62	107	254
Ceb 1484	4607	104	8.0	67	64	104	249
Ceb 1471	3485	79	6.7	62	62	101	282
SW 955180	4596	104	8.3	81	65	104	206
F12-7	4143	94	8.3	71	65	104	209
F12-31	3990	80	7.4	72	65	103	217
F13-32	3850	87	7.4	67	61	101	233
Ceb 1483	3803	86	7.0	60	62	102	265
CDC 9805	4948	112	8.7	84	64	106	190
Ceb 1489	3490	79	9.0	66	62	101	255
DS 49376	3825	87	6.7	84	64	103	244
CDC 9809	4071	92	9.0	88	64	105	185
Green							
Keoma	3337	76	9.0	62	64	99	201
MP 1802	3216	73	5.4	69	65	103	251
SW 94623	3557	81	8.7	75	63	103	209
DS 49310	3241	73	8.4	69	64	105	211
Ceb 1158	3720	84	9.0	62	64	102	252
Ceb 1166	4154	94	7.3	81	64	103	240
Ceb 1171	4755	108	8.7	74	64	104	259
Ceb 1163	2987	68	6.7	51	62	103	247
Ceb 1172	3624	82	7.4	64	65	103	297
CDC 9801	4329	98	7.6	88	61	104	224
CDC 9803	3735	85	9.0	73	65	104	169
Red							
Ceb 1486	3085	70	8.4	65	62	102	209
Ceb 1487	3211	73	8.0	63	62	102	223

[1]10% of plants/plot have open flowers
[2]75% of plants/plot are yellow and dry

Table 28. Yield and agronomic data for the irrigated Pea Co-operative test C.

Variety	Yield (kg/ha)	Yield % of Carneval	Lodging 0 = erect 9 = flat	Vine length (cm)	Days to 10% flower[1]	Days to maturity[2]	Seed weight (mg)
Yellow							
Carrera	3675	90	7.3	53	62	103	263
Carneval	4106	100	6.7	66	65	103	228
CDC 9705	4043	98	9.0	51	65	103	250
MP 1763	3488	85	8.0	64	65	103	255
4-0748-2	3010	73	7.0	58	60	99	257
DS 49361	3499	85	6.3	70	64	103	197
SG-L14	4062	99	7.3	69	65	103	267
PF 1039.11	4276	104	7.3	56	58	99	279
NSA 93-0030-2	2860	70	5.0	57	57	97	271
SW 955142	3577	87	6.3	56	64	103	222
ADV 3154.7	3421	83	6.0	52	65	101	267
UN 407	3581	87	8.0	56	60	101	278
NORD 95/208	3867	94	6.3	74	54	103	239
ADV 014.17	3955	96	7.3	74	58	103	211
Green							
Keoma	2877	70	9.0	45	65	97	218
ADV 203.13	3409	83	7.0	55	63	103	232

[1]10% of plants/plot have open flowers
[2]75% of plants/plot are yellow and dry

Regional Variety Test of Dry Bean and Chickpea

T. Hogg[1], M. Pederson[1], A. Vandenberg[2], T. Warkentin[2]

Funded by the Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Ongoing*

Objective: *To assess the dry bean and chickpea production potential of targeted environments within Saskatchewan using current and newly released varieties.*

The potential for development of the dry bean and chickpea sectors of Saskatchewan's pulse industry has been limited by the lack of adapted varieties. Adapted breeding lines from the Crop Development Centre (CDC), U of S, Saskatoon, Saskatchewan, are at the stage of recommendation for registration. The next step in the development process is regional testing of new varieties. Regional performance trials provide information on the various production regions available in Saskatchewan to assess productivity and risk. This information is used by extension personnel, pulse growers and researchers across Saskatchewan to become familiar with these new pulse crops.

[1]*CSIDC, Outlook*
[2]*Crop Development Centre, U of S, Saskatoon, Saskatchewan*

Regional variety trials were established in the spring of 1999 at the CSIDC for irrigated dry bean located on the NW12-29-08-W3 and for dryland chickpea located on the SW15-29-08-W3. Separate trials were run for dry bean under wide row (60 cm/24 in) and narrow row (20 cm/8 in) cropping. Chickpea was seeded using narrow rows (20 cm/8 in). The variety treatments were arranged in a randomized complete block design with three replicates. Each treatment measured 1.2 m x 3.7 m (4 ft x 12 ft).

Dry Bean

For all bean varieties higher yields were obtained under narrow row compared to wide row conditions (Table 28 and 29). This was partly due to the fact the the narrow row trial was situated on a slightly lighter textured soil and suffered some stand loss due to sand blasting early in the stand establishment. Viva (pink) and Othello (pinto) produced the highest overall yields while the black varieties CDC Nighthawk and CDC Expresso had very poor yields. Some of the new varieties produced yields similar to the checks within each market class. The pinto varieties CDC Pinnacle, CDC Pintium and CDC Altiro appear to be high yielding varieties, which produced yields similar to Othello. The great northern variety CDC Bianca and the pink variety 93318 also appear to be high yielding.

Table 29. Irrigated Dry Bean Regional variety trial - narrow row.

Variety	Yield (kg/ha)	Lodging 0 = erect 9 = flat	Plant height (cm)	Days to flower	Days to maturity[1]	Seed weight (mg)	Pod clearance (%)[2]
Pinto							
Othello (check)	1044	2	36	61	112	283	43
CDC Camino (check)	452	1	32	61	115	279	81
CDC Pinnacle	1017	2	39	60	114	304	59
CDC Pintium	1053	2	30	57	102	319	85
CDC Altiro	694	2	37	59	112	296	73
Great Northern							
CDC Nordic (check)	708	3	33	61	114	282	56
US 1140 (check)	918	4	35	65	118	252	43
CDC Bianca	1163	2	34	59	107	353	57
CDC Crocus	1691	3	42	59	115	300	79
93407	1043	4	36	66	115	311	67
Pink							
Viva (check)	1189	2	34	63	116	198	45
93318	1020	4	42	62	119	218	55
95-34-6PK	789	2	40	63	113	254	59
Black							
CDC Nighthawk	104	3	32	70	119		52
CDC Expresso	223	2	31	60	115	156	52
S.E.	72.5	0.2	0.7	0.5	0.8	8.2	2.8
CV (%)	36.9	31.3	9.6	2.9	2.9	4.8	24.4

[1]50% of pods are buckskin colored
[2]% pods >5cm (2 in) above ground surface

Most bean varieties flowered within a range of 57 - 67 days. CDC Nighthawk flowered later than the other varieties. Some of the new varieties flowered earlier than the checks.

The pinto variety CDC Pintium matured up to 2 weeks earlier than the later maturing varieties. Most varieties required 115-118 days to mature. The late maturity of some of the varieties was probably due to the cool growing conditions and early fall frost experienced in 1999.

Pod clearance varied among the varieties. Some of the newer pinto varieties had better pod clearance than Othello. The same was found for the Great Northern varieties where the new varieties Nordic, CDC Bianca and CDC Crocus had better pod clearance than US 1140. The new pink varieties 93318 and 95-34-6PK had better pod clearance than Viva. The black varieties had lower pod clearance than in previous years and was probably due to the poor growing conditions experienced in 1999.

Seed size was larger for some of the new varieties compared to the checks in each market class. The highest seed weight was obtained for the new great northern variety CDC Bianca. The new pinto varieties CDC Pintium and CDC Altiro had seed weight higher than Othello. As well, the new pink varieties 93318 and 95-34-6PK had seed weight higher than Viva. Seed weight for the pink market class was less than either that of the pinto or great northern varieties. The black market class had the lowest overall seed weight.

Plant height was similar for all varieties except for the black varieties which were the shortest.

Chickpea

No yield estimates were obtained for either the desi or kabuli chickpea trials. The cool growing season and early fall frost provided ideal conditions for vegetative growth but not enough stress to allow seed set.

Days to flower were similar for the desi and kabuli varieties (Table 30 and 31). The kabuli varieties were taller than the desi varieties.

Table 30. Irrigated Dry Bean Regional variety trial - wide row.

Variety	Yield (kg/ha)	Lodging 0 = erect 9 = flat	Plant height (cm)	Days to flower	Days to maturity[1]	Seed weight (mg)	Pod clearance (%)[2]
Pinto							
Othello (check)	1760	5	47	66	116	293	51
CDC Camino (check)	1321	2	44	63	116	283	55
CDC Pinnacle	1526	5	50	65	119	294	42
CDC Pintium	1609	2	42	61	102	303	76
CDC Altiro	1497	3	52	60	116	311	60
Great Northern							
CDC Nordic (check)	1179	4	37	61	115	279	60
US 1140 (check)	1236	6	47	66	121	259	48
CDC Bianca	1559	4	43	66	113	355	51
CDC Crocus	1399	5	49	61	116	298	56
93407	1418	4	44	67	116	316	57
Pink							
Viva (check)	1763	8	48	61	116	219	58
93318	1583	4	51	61	118	241	61
95-34-6PK	1267	6	48	63	118	288	76
Black							
CDC Nighthawk	343	2	40	70	121	137	53
CDC Expresso	404	2	37	59	118	161	48
S.E.	72.4	0.3	0.9	0.5	0.8	8.1	2.1
CV (%)	20.6	23.3	7.5	0.5	2.7	4.4	21.1

[1]50% of pods are buckskin colored
[2]% pods >5cm (2 in) above ground surface

Table 31. Kabuli chickpea Regional variety trial.

Variety	Days to flower	Plant height (cm)
Sanford (check)	53	92
CDC Yuma (check)	50	85
CDC Chico (check)	50	90
CDC Xena	49	80
X39	49	86
EVANS	50	97
92-67-4K	50	84
93-113-59K	50	83
93-120-63K	50	92
92009-10K	50	89
92060-11K	50	89
92014-13K	50	91
S.E.	0.2	0.9
CV (%)	1.8	4.2

Table 32. Desi chickpea Regional variety trial.

Variety	Days to flower	Plant height (cm)
CDC Desiray (check)	51	71
Myles (check)	51	80
92056-50	52	80
92117-25D	52	90
92040-52	50	76
92-050-26D	51	80
92073-40	50	92
92073-60	50	82
92085-21	49	87
92117-14	53	89
92056-22	53	83
92039-5	51	72
S.E.	0.3	1.3
CV (%)	2.3	4.6

Regional Adaptation of Pulse Crops

T. Hogg[1], M. Pederson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year three of five*

***Objective:** To demonstrate a variety of pulse crop types in large plots, determining relative performance in the irrigated area of Saskatchewan.*

Pulse crops are an important part of the rotation. They fix a large proportion of their own nitrogen requirements and they help to break up the disease cycle of other crops. Variety evaluation is important to determine the best crop type for a given
Agro-ecological region.

A pulse crop variety demonstration was established at the CSIDC in the spring of 1999. Six varieties of dry bean and pea and two varieties each of faba bean, lentil, chickpea and soybean were sown. Separate tests were conducted for each pulse crop type due to differences in irrigation requirements. The dry bean varieties were row crop cultivated using 60 cm (24 in) row spacing. All other pulse crops were solid seeded using a row spacing of 25 cm (10 in).

Dry Bean

CDC Expresso was the first while Othello and CDC Camino were the last varieties to reach 50% flowering with little difference among the other varieties (Table 32). CDC Expresso black bean was the earliest maturing variety while NW63 small red bean required a longer period to reach maturity than the other dry bean classes. Yield was on the order pinto > pink> small red, great northern > black. Yields were average probably due to the cool growing conditions in 1999.

Pod clearance rating, an indicator of suitability for direct cut harvesting, varied among dry bean classes as well as between varieties within a class. CDC Camino pinto bean and CDC Expresso black bean had the best pod clearance overall. The lowest pod clearance rating was obtained for NW63 small red bean and Othello pinto bean. The pod clearance rating for the pink and great northern varieties was

Table 33. Yield and agronomic data for the irrigated Dry Bean variety adaptation trial.

Variety	Days to 10% flower	Days to maturity	*Sclerotinia* Extent (0 - 5)	*Sclerotinia* Severity (0 - 5)	Pod clearance rating (%)	Plant height (cm)	Lodging rating (0 = erect; 9 = flat)	Yield @ 16% moisture (kg/ha)	Seed weight (mg)	Water use (cm)
Othello	62	104	3	4	38	45	3	2855	332	36
CDC Camino	60	105	3	3	76	49	2	2875	330	36
CDC Expresso	49	103	0	0	72	43	1	2372	175	34
CDC Nordic	53	108	3	3	53	42	5	2522	336	36
NW63	55	111	1	2	36	45	3	2530	266	34
Viva	55	109	2	2	43	43	4	2701	214	35
S.E.					5	1		233	8	1
CV (%)					23.4	4.6		21.6	7.4	4.8

[1]CSIDC, Outlook

intermediate to that of the other varieties. Water use was similar amongst all varieties.

Pea

The newly registered varieties CDC Handel and CDC Mozart were earlier flowering than the other varieties (Table 33). Grande was the latest of the varieties to mature while Keoma was the earliest maturing variety. Disease, powdery mildew and mycosphaerella, was present on all varieties with Keoma and CDC Mozart being infected to the greatest extent. Keoma and CDC Mozart were the shortest varieties. All varieties lodged to some extent with Keoma, CDC Mozart and Grande lodging to the greatest extent while Carneval showed the least lodging. Yield was greatest for Majoret while CDC Handel had the lowest yield of all pea varieties. Water use was similar amongst all varieties.

Table 34. Yield and agronomic data for the irrigated Field Pea variety adaptation trial.

Variety	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating (0 = erect; 9 = flat)	Yield @ 16% moisture (kg/ha)	Seed weight (mg)	Water use (cm)
			Extent[1] (0 - 5)	Severity[2] (0 - 5)					
Grande	66	106	3	3	105	9	3249	179	41
Carneval	65	103	4	3	92	7	3718	163	38
CDC Handel	61	102	4	4	98	9	2847	133	41
CDC Mozart	61	100	5	5	85	8	2966	158	36
Keoma	64	99	5	5	81	9	3118	155	38
Majoret	65	103	4	3	94	8	4559	235	41
S.E.					2		105	4	1
CV (%)					5.7		7.6	5.8	6.6

[1]0=trace; 3=15-25%; 5=50%
[2]0=none; 3=moderate;5=very severe

Fababean

There was no difference in the two varieties in flowering date, days to reach maturity or plant height (Table 34). Chocolate spot disease was present to the same extent on both varieties. Yield was higher for Aladin which also had a larger seed size. Water use was similar between the two varieties.

Table 35. Yield and agronomic data for the irrigated Faba Bean variety adaptation trial.

Variety	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating (0 = erect; 9 = flat)	Yield @ 16% moisture (kg/ha)	Seed weight (mg)	Water use (cm)
			Extent[1] (0 - 5)	Severity[2] (0 - 5)					
Aladin	64	118	3	2	101	2	6141	423	43
CDC Fatima	64	118	3	2	100	2	5959	413	45
S.E.					4		497	8	2
CV (%)					5.4		11.6	2.8	6.5

[1]0=trace; 3=15-25%; 5=50%
[2]0=none; 3=moderate;5=very severe

Lentil

No irrigation water was applied due to the above normal rainfall in July and the cool growing conditions throughout the growing season. There was little difference between the two varieties for time to flowering or maturity (Table 35). Foliar disease, although present, was kept under control with the application of Bravo at early flower. Yield was highest for Vantage, an aschochyta resistance medium yellow lentil variety, compared to Glamis, an aschochyta resistance Laird type lentil. Water use was similar between the two varieties.

Table 36. Yield and agronomic data for the irrigated Lentil variety adaptation trial.

Variety	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating (0 = erect; 9 = flat)	Yield @ 16% moisture (kg/ha)	Seed weight (mg)	Water use (cm)
			Extent[1] (0 - 5)	Severity[2] (0 - 5)					
CDC Glamis	62	111	3	3	60	5	2342	53	30
CDC Vantage	64	111	2	2	52	5	2677	59	32
S.E.					4		278	6	3
CV (%)					8.8		15.7	15.8	1.0

[1]0=trace; 3=15-25%; 5=50%
[2]0=none; 3=moderate;5=very severe

Chickpea

No irrigation water was applied due to the above normal rainfall in July and the cool growing conditions throughout the growing season. Sanford, a kabuli type chickpea, took a longer time to reach 50% flowering than Myles, a desi type chickpea (Table 36). Days to maturity was longer for Myles than Sanford possibly due to the greater presence of foliar disease in the Sanford compared to the Myles. Bravo was applied at early flower for control of foliar disease; however, total control was not achieved. Sanford was taller than Myles. Sanford seed size was smaller than for Myles. The small seed size for Sanford was possibly due to the effect of foliar disease. Water use was similar between the two varieties.

Table37. Yield and agronomic data for the irrigated Chickpea variety adaptation trial.

Variety	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating (0 = erect; 9 = flat)	Yield @ 16% moisture (kg/ha)	Seed weight (mg)	Water use (cm)
			Extent[1] (0 - 5)	Severity[2] (0 - 5)					
Sanford	65	121	5	5	88	1	721	116	33
Myles	60	124	3	2	76	1	2186	139	34
S.E.					1		251	20	2
CV (%)					2.3		24.4	22.2	9.7

[1]0=trace; 3=15-25%; 5=50%
[2]0=none; 3=moderate;5=very severe

Soybean

Both varieties flowered at the same time (Table 37), however, only the KG20 reached maturity before the first fall killing frost. Terramax was taller than KG20. Yield and seed weight was greater for KG20 compared to Terramax. Yield was low for both varieties probably due to the cool growing season and early killing fall frost. Water use was similar between the two varieties.

Table 38. Yield and agronomic data for the irrigated Soybean variety adaptation trial.

Variety	Days to 10% flower	Days to maturity	Plant height (cm)	Lodging rating (0 = erect; 9 = flat)	Yield @ 16% moisture (kg/ha)	Seed weight (mg)	Water use (cm)
Terramax	71	froze	97	1	1088	82	37
KG 20	71	119	86	1	1763	126	38
S.E.			1		28	3	1
CV (%)			1.2		2.8	4.5	5.0

Pea and Bean Preliminary Yield Trials

A. Vandenberg[1], T. Warkentin[1], T. Hogg[2]

Funded by Saskatchewan Agriculture Development Fund (SADF); Saskatchewan Pulse Growers (SPG), and the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress**: Ongoing*

***Location:** CSIDC*

Objective:
- To develop high yielding, disease resistant green and yellow pea varieties.
- To develop high yielding, adapted dry bean varieties.

Pea Trials

Field pea trials conducted at Outlook identified several high-yielding green and yellow field pea breeding lines. Fourteen two-replicate trials of 36 entries each were grown. Most of the lines were resistant to powdery mildew. Lines with the highest yield and best lodging tolerance were advanced to registration recommendation trials for the 2000 season. Green-seeded lines were evaluated for tolerance to bleaching.

Bean Trials

Dry bean trials were conducted at Outlook to identify early-maturing, high yielding breeding lines in the pinto, black, navy, great northern, red and pink market classes for the narrow-row production system. Eight 36-entry advanced trials were grown. Each trial had two replications. Three replicates of the 1999 Prairie Dry Bean Co-op Trials ("A" with 12 entries; "B" with 36 entries) were also grown. Data from trials were combined with those from other locations to decide which lines to advance to the 2000 Prairie Dry Bean Co-op Trials – Narrow Row.

[1]*Crop Development Centre, U of S, Saskatoon*
[2]*CSIDC, Outlook*

Weed Control in Special Crops

L. Townley-Smith[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year three of five*

Objective: *To develop data in support of minor use registration of herbicides for weed control in seedling stands of selected grasses.*

Successful production of special crops depends on good weed control. One important means of weed control is the use of herbicides. However, for many special crops, there are few, if any, herbicides available. Outlook is one of six Saskatchewan sites where minor use registration data for special crops was collected in 1999.

The seeding and herbicide application information is included with each trial. All trials were four replicate randomized complete blocks grown under irrigated conditions. Irrigation and fertility management were done in accordance with standard practice for that crop. All crops received P_2O_5 as 11-52-0 and all non-legume crops received at least 100 kg/ha of nitrogen.

Rating data was collected 14 and 28 days after treatment using a 0-100 scale. Analysis of variance was followed by pre-determined contrasts to determine differences between groups of means and individual means of interest.

Dry Bean

Odyssey/glyphosate treatments delayed crop development and maturity of Black, Pinto and Great Northern beans, but gave excellent control of green foxtail and volunteer canola. Assure II showed excellent crop tolerance. Yield was not measured as late seeding coupled with slow early season growth resulted in frost damage before the beans matured (Table 1).

Seeding date:	*June 4*
Seeding rate:	30 seeds/m²
Row spacing:	*25 cm*
Application volume:	*100 L/ha*
Herbicide applications:	
Odyssey/Glyphosate: *June 8, (after seeding, before emergence)*	
Assure II: *July 7*	

Sunflower

The sunflower test consisted of Select (Clethodim) at 46 and 92 grams a.i./ha. The sunflower showed good tolerance to both rates averaging 99 and 95 respectively. The plot area was nearly weed free. Populations were too low to rate weed control.

Seeding date:	*June 8*
Seeding rate:	*20 plants/m²*
Row spacing:	*25 cm*
Application volume:	*100 L/ha*
Herbicide application:	*July 8*

[1]*CSIDC, Outlook*

Table 1. Crop tolerance and weed control in black, pinto and great northern dry beans.

Treatment	UI906 Black		Othello Pinto		US1140 Great Northern		Volunteer Canola	Green Foxtail
	14 days[1]	28 days[1]	14 days[1]	28 days[1]	14 days[1]	28 days[1]	14 days[1]	14 days[1]
Assure II 40	98	100	98	100	98	100	0	83
Assure II 80	100	100	100	100	100	100	0	88
Odyssey 15 Glyphosate 450	97	87	97	87	95	87	100	93
Odyssey 30 Glyphosate 450	95	87	97	87	97	87	100	98
Untreated check	100	100	100	100	100	100	0	0
Contrasts	--------------------------F-ratio------------------------------							
check v sprayed	1.29	10.67	1.79	10.67	1.44	10.67	**	344
Assure v Odyssey	2.86	53.33	3.21	53.33	3.20	53.33	**	5.07
Assure rates	0.36	0.00	0.71	0.00	0.40	0.00	**	0.63
Odyssey rates	0.36	0.00	0.00	0.00	0.40	0.00	**	0.63

[1]days after post-emergent applicaton, **not estimated as error mean square = 0

Desi and Kabuli Chickpea

Odyssey and Odyssey/ Glyphosate treatments delayed crop development and maturity of Desi and Kabuli chickpeas (Table 2). Bladex had good crop tolerance. Yield was not measured. Late seeding coupled with a wet growing season and irrigation resulted in almost no seeds being set before mid-September when frost ended growth. Both Desi and Kabuli chickpea tolerated Dual II, Dual II/Linuron, and Lentagran. Tolerance of Prometryn was barely acceptable. Tolerance of Fomsafen was poor. The third trial involving Reglone desiccation was abandoned after spraying due to extremely late maturity and frost in mid-September.

Seeding date: *June 3*
Seeding rate: *40 plants/m²*
Row spacing: *25 cm*
Application volume: *100 L/ha*
Herbicide applications:
- Odyssey and Odyssey/Glyphosate - *June 8, after seeding, before emergence*
- Odyssey Post-emergence and Bladex - *July 7*
- Dual II and Dual II/Linuron - *May 26, pre-planting, incorporated with a rotovator to a depth of 8 cm*
- Fomsafen, Lentagran, Prometryn - *July 6*

Borage

By 28 days all crop tolerance differences were not detectable except the Lontrel treated plots which appeared to be slightly lighter in colour. On close examination, it appeared there were fewer flowers open on the plants. The plots receiving the higher rate of Lontrel appeared whiter than the low rate plots. Borage suppressed both the broadleaf and grassy weeds by the second rating date. Yields were unobtainable due to shattering.

Seeding date: *May 28*
Seeding rate: *10 kg/ha*
Row spacing: *25 cm*
Application volume: *100 L/ha*
Herbicide application: *July 8*

Table 2. Crop Tolerance and weed controlin chickpea with Bladex and Odyssey.

Treatment	Myles Desi		Sanford Kabuli		Green Foxtail
	14 days[1]	28 days[1]	14 days[1]	28 days[1]	14 days[1]
Bladex 960	90	88	93	88	5
Bladex 1440	89	90	89	93	20
Odyssey 15 Pre	80	60	81	63	78
Odyssey 30 Pre	43	46	42	48	86
Odyssey 60 Pre	50	53	50	53	85
Odyssey 15 Pre Glyphosate 450	68	55	68	60	90
Odyssey 30 Pre Glyphosate 450	58	50	56	55	95
Odyssey 60 Pre Glyphosate 450	28	30	28	30	99
Odyssey 10 Post	50	50	53	50	60
Odyssey 20 Post	50	43	50	43	73
Odyssey 30 Post	42	26	40	27	70
Check	100	100	100	100	0
Contrasts	---------------------------F-ratio------------------------------				
Check v sprayed	26.0**	30.8**	27.4**	29.8**	54.2**
Bladex v Odyssey	38.1**	46.9**	43.4**	47.8**	96.8**
Between Bladex	0.01	0.05	1.12	0.20	1.39
Odyssey Pre (+/- Glyph) v Odyssey Post	1.46	1.73	1.54	3.10	9.60**
Odyssey v Odyssey+Glyph	1.18	1.24	1.52	0.71	2.82
Among Odyssey Pre	6.89	1.13	7.98	1.24	0.24
Among Odyssey+Glyph	7.22	2.75	7.53	4.22	0.24
Among Odyssey Post	0.28	1.32	0.69	1.36	0.59

[1]days after post-emergent applicaton, **not estimated as error mean square = 0

Table 3. Crop tolerance and weed control in chickpea with Dual, Linuron, Fomsafen, Lentagren, and Prometryn.

Treatment	Myles Desi		Sanford Kabuli		Volunteer canola	Green foxtail
	14 day[1]	28 day[1]	14 day[1]	28 day[1]	14 day[1]	14 day[1]
Dual II 1000 Linuron 400 PPI	93	98	93	98	0	94
Dual II 2000 Linuron 800 PPI	100	100	100	100	0	98
Dual II 1000 PPI	99	100	99	100	0	94
Dual II 2000 PPI	95	98	98	98	0	94
Fomsafen 250+Agral 90	30	40	30	43	75	75
Fomsafen 500+Agral 90	30	23	30	30	100	70
Lentagran 900+Agral 90	84	95	83	95	80	25
Lentagran 1200+Agral 90	84	98	85	98	80	30
Lentagran 1800+Agral 90	83	95	83	95	83	38
Prometryn 300+Agral 90	90	95	88	95	60	8
Prometryn 600+Agral 90	81	95	79	95	86	35
Check	100	100	100	100	0	0
Contrasts	--F-ratio--					
Among treatments	23.9**	87.7**	23.3**	88.4**	14.7**	21.9**
Check v sprayed	16.2**	28.0**	16.0**	28.0**	36.7**	29.3**
Dual v Dual+Linuron	0.02	0.00	0.13	0.00	0.04	0.00
Fomasafen v Lentagran & Prometryn	166**	771**	155**	771**	33.0**	1.66
Lentagran v Prometryn	0.25	0.13	0.00	0.13	1.23	0.87
Dual + Linuron rates	1.11	0.48	1.08	0.48	0.08	0
Dual rates	0.28	0.48	0.03	0.48	0.00	0
Fomasafen rates	0.01	4.32*	0.00	12.0**	0.14	3.8
Lentagran rates	0.02	0.32	0.08	0.32	0.44	0.03
Prometryn rates	1.51	0.00	1.46	0.00	4.22*	4.20*

[1]days after post emergent application

Table 4. Crop tolerance and weed control in Borage.			
Treatment	Borage 14 days[1]	Volunteer Canola 14 days[1]	Green Foxtail 14 days[1]
Assert 250	88	95	15
Assert 500	90	73	20
Assert 1000	98	98	0
Lontrel 150	90	0	0
Lontrel 300	90	25	0
Select 46	93	0	98
Select 92	97	0	99
Untreated	100	0	0
Contrast		F-ratio	
Among treatments	1.48	11.3**	28.2**
Check v sprayed	3.82	8.58**	14.3**
Assert rates	1.92	1.08	1.62
Lontrel rates	0.00	1.78	0.00
Select rates	0.88	0.00	0.01

[1]days after post-emergent application

Canary Seed

Yield was not significantly affected by treatments. Refine had poorer crop tolerance than Attain, but tolerance was good by 28 days after treatment. By 35 days after treatment, the check and Refine plots had lodged, the Attain had not. By harvest in mid-September, all plots showed some lodging.

Seeding date:	*May 28*
Seeding rate:	*400 seeds/m²*
Row spacing:	*25 cm*
Application volume:	*100 L/ha*
Herbicide application:	*July 7*

Table 5. Canary seed crop tolerance and yield.			
Treatment	Visual Rating		Yield (kg/ha)
	14 days[1]	28 days[1]	
Attain 108+564, Post E	93	97	1154
Attain 216+1128, Post E	85	96	1125
Refine Extra 15+Agral 90 0.2% v/v, Post E	83	93	1190
Refine Extra 30+Agral 90 0.2% v/v, Post E	75	93	1000
Untreated Check	100	100	1245
Contrasts		F-ratio	
Check v treated	26.72**	25.66**	0.82
Attain v Refine	11.56**	13.03**	0.11
Attain rates	3.70	0.28	0.03
Refine rates	2.57	0.00	1.13

[1]days after post-emergent application

Caraway, Coriander and Dill

Seeding date:	*May 27*
Seeding rate:	*10 kg/ha*
Row spacing:	*25 cm*
Application volume:	*100 L/ha*
Herbicide application:	*July 7*

Tolerance to Select (clethodim) was excellent in all three crops. Tolerance to Select & Linuron was good in coriander, marginal in dill and annual caraway. Tolerance to Pardner was acceptable in coriander but marginal to poor in dill and annual caraway.

Table 6. Weed control in spice crops.

Treatment	Caraway		Dill		Coriander	
	14 days	28 days	14 days	28 days	14 days	28 days
Pardner 140	70	68	70	73	80	90
Pardner 280	63	63	63	55	85	90
Select 46 Linuron 800	90	78	85	85	90	95
Select 92 Linuron 1600	88	63	83	70	88	90
Select 46	100	93	98	100	95	93
Select 92	100	100	100	100	100	98
Untreated	100	100	100	100	100	100
Contrasts	F- ratio					
Among treatments	11.7**	5.06**	12.3**	17.9**	3.03*	0.87
Check v sprayed	9.67**	7.89*	13.7**	18.3**	4.86*	2.57
Select (+/-Linuron) v Pardner	52.9**	7.68*	45.7**	46.4**	7.86*	1.00
Select v Select + Linuron	6.35*	12.1**	12.3**	28.2**	4.00	0.33
Pardner rates	1.41	0.22	1.54	8.53**	0.65	0.00
Select/Linuron rates	0.16	1.97	0.17	6.27*	0.16	0.67
Select rates	0.00	0.49	0.17	0.00	0.65	0.67

Weed Control in Fenugreek

Green foxtail, volunteer canola and red-root pigweed were controlled by Odyssey. This treatment caused significant stunting of the fenugreek. Yield was not taken as frost injury prevented maturity of the crop. Edge and Select showed good crop tolerance.

Seeding date:	*June 3*
Seeding rate:	*80 seeds/m²*
Row spacing:	*25 cm*
Application volume:	*100 L/ha*

Herbicide applications:

Odyssey and Edge: *May 26*

Edge incorporated 8cm (3 in) while Odyssey was not.

Other product applied: *July 7*

Table 7. Crop tolerance and weed control in Fenugreek.

Treatment	Fenugreek		Green Foxtail	Volunteer Canola	Red-root Pigweed
	14 days[1]	28 days[1]	14 days[1]	14 days[1]	14 days[1]
Edge 840	96	100	100	20	93
Edge 1680	91	100	100	23	98
Odyssey 15	68	79	80	98	100
Odyssey 30	50	58	98	100	100
Odyssey 60	33	48	100	100	100
Select 46	93	95	81	85	80
Select 92	90	100	98	85	95
Untreated	100	100	0	0	0
Contrasts	F-ratio				
Among treatments	23.4**	62.3**	39.7**	18.9**	48.9**
Check v sprayed	22.0**	35.8**	261**	49.9**	329**
Edge rates	0.48	0.00	0.00	0.03	0.81
Odyssey rates	11.7**	34.7**	4.03*	0.02	0.00
Select rates	0.12	1.70	4.49*	0.00	4.67*

[1]days after post-emergent application

Industrial Hemp Varietal Analysis for Δ-9 THC Testing

L. Townley-Smith[1], I. Bristow[2]

Eleven fibre hemp varieties were evaluated for THC content and for relative performance under irrigation. The hemp was sown on June 22 (after receiving regulatory approval) in 1.5 x 6 m (5 x 20 ft) plots on a 25 cm (10 in) row spacing. The plots were harvested for dry matter yield on October 21. Sub-samples were collected for chemical analysis.

A wide range in growth habit, from spindly to tall and bush-like, was noted for the eleven varieties, which reached a height of approximately 2.4 m (8 ft). Several varieties produced high yield and vigorous growth under irrigation.

Dry weight production of the varieties are shown in Table 1. THC levels were near or below detectable limits in laboratory testing.

Table 1. Dry matter yield for hemp varieties grown under irrigation.

Variety	Dry matter yield	
	kg/ha	tons/ac
Fasamo	4001	1.77
Fedora 19	8168	3.62
Fedrina 74	8710	3.86
Felina 34	9752	4.33
Ferimon	7626	3.38
Fin 314	2334	1.04
Futura	9168	4.07
Uniko B	4917	2.18
USO 14	7210	3.20
USO 31	4042	1.79
Zolotonosha 11	1542	0.68

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Potato Development Program

Potato Development Program

The Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) has expanded its potato research and development program to support the needs of this expanding industry.

Objective:
- To identify cultivars for the seed, table, and processing markets,
- To develop of cost-effective agronomic practices to suit the relatively short and cool growing seasons of Saskatchewan, and
- To develop of economically viable and sustainable potato-based crop rotations.

The potato industry is growing rapidly in Saskatchewan. Saskatchewan has become one of the leading seed potato producers and exporters in North America. This is mainly due the phenomenon of 'Northern Vigour™' and the disease-free status of seed tubers produced in this province. The major target markets include the U.S.A, Mexico, and other Canadian provinces. Efforts are also being taken to explore seed potato markets in other countries. Studies are being conducted to evaluate suitable germplasm and refine production techniques for growing seed, processing and table potato in Saskatchewan.

These projects are conducted jointly with Saskatchewan Seed Potato Growers Association, Dr Doug Waterer (Department of Plant Sciences, University of Saskatchewan), Dr. Dermot Lynch (Lethbridge Research Centre, Agriculture and Agri-Food Canada), and the private industry. The potato research and develop program at the CSIDC was carried out with financial support from the Canada-Saskatchewan Agri-Food Innovation Fund.

The tests were conducted in the field plots of the CSIDC. The crop was raised under irrigation using standard management practices with treatments applied appropriately as required by the different tests. The common production practices included (i) Eptam 8E as pre-plant herbicide, (ii) 90 cm (36 in) row spacing, (iii) 200 kg N/ha (180 lbN/ac) (half at planting and half at hilling); 60 kg P_2O_5/ha (55 lb P_2O_5/ac); 50 kg K_2O/ha (40 lb K_2O/ac), (iv) one application of Ripcord for Colorado potato beetle control, (iv) Bravo 500, Dithane, and Acrobat for disease control, and (vi) two applications of Reglone as top-kill. The crop received 207 mm (8.1 in) of rain during the growing season and 140 mm (5.5 in) of supplemental irrigation was applied to maintain soil moisture status at approximately 65% Field Capacity (FC). The harvested tubers were graded according to tuber diameter. The 'seed' grade comprised of tubers between 25 mm (1 in) and 70 mm (2.75 in) for oblong cultivars or 25mm (1 in) and 80 mm (3.15 in) for round cultivars. The 'consumption' category included tubers larger than 45 mm (1.75 in) diameter. Tuber specific gravity and culinary characteristics (boiled, baked, chip, and french fry) were determined using recommended protocols. Fry colour categories were based on the USDA classification.

[1]Northern Vigor™ is a Trade Mark of the Saskatchewan Seed Potato Growers Association.

Prairie Regional Trials

J. Wahab[1], D. Lynch[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation fund (AFIF)

The Prairie Regional 'Early' and 'Main Crop' trials were conducted at CSIDC under irrigation. The 'Early' test included six advanced generation clones and four industry standards. The 'Main Crop' trial evaluated 18 advanced clones in relation to seven commercial cultivars. The 'Early' trial was harvested at 80 and 100 days after planting and the 'Main Crop' test was harvested after 125 days from planting. The yield performance and culinary characteristics were determined for the harvested tubers. This information will be used to support registration of new cultivars.

Western Seed Potato Consortium

J. Wahab[1], D. Lynch[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation fund (AFIF)

Promising table, french fry, and chipping clones offered to the Western Seed Potato Consortium were grown in single-row plots under standard management practices suited for irrigation. The crop was harvested and displayed to the members during the field day held on August 12, 1999. Over 100 producers, industry personnel, and resource persons attended this field day.

Industry Cultivar Evaluation

J. Wahab[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation fund (AFIF)

The new potato cultivars Appell, Arnova, Columbo, Eloge, and Innovator were evaluated in comparison with industry standards Norland (red/table), Russet Norkotah (white/table), Russet Burbank (late-season/french fry), and Shepody (mid-season/french fry).

The cultivar Arnova produced the lowest stem count per hill (2.2) (Table 1). Stem count for the other new entries ranged between 2.5 and 3.0. The mainstem number for the check cultivars ranged between 2.5 and 3.1 per hill.

Arnova produced the highest 'seed' and 'consumption' grade yields (Table 1). All the introduced cultivars produced similar or higher 'seed' and 'consumption' grade yields relative to check cultivars.

[1]*CSIDC, Outlook*
[2]*Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta*

Table 1. Cultivar effects on mainstem number, 'seed' and 'consumption' grade yields.

Treatment	Mainstem number (per hill)	Seed grade yield		Consumption grade yield	
		t/ha	Cwt/ac	t/ha	Cwt/ac
Appell	3.1	58.5	521.9	27.5	245.4
Arnova	2.2	74.6	665.6	74.6	665.6
Columbo	2.5	58.1	518.4	44.1	393.5
Eloge	3.0	72.1	643.3	49.1	438.1
Innovator	2.9	56.7	505.9	52.8	471.1
Norland	2.5	44.2	394.4	36.8	328.3
Russet Burbank	2.5	51.5	459.5	36.5	325.7
Russet Norkotah	3.1	49.9	445.2	40.5	361.3
Shepody	2.6	56.9	507.7	53.8	480.0
Analyses of Variance					
Variety	*(0.5)	***(8.2)		***(9.7)	
CV (%)	12.2	9.6		14.4	

***, *, and NS indicate significance at P<0.001, 0.05 levels of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Irrigation and Seed Piece Spacing

J. Wahab[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Potato responds well to irrigation. Moisture stress can reduce tuber yield and quality characteristics. On the other hand, excess moisture can adversely affect tuber specific gravity and fry colour of processing potato. Previous studies at CSIDC have shown that irrigation is beneficial to potato production and moisture stress can cause severe yield losses and affect tuber quality. This study compared the performance of Atlantic, Norland, Russet Burbank, Russet Norkotah, and Shepody potato at three seed piece spacings (15, 20, 30 cm; 6, 8, 12 in) under three irrigation regimes (dryland, 40% FC, 65% FC).

The growing season received 207 mm (8.1 in) rain. Supplementary irrigation of 100 mm (3.9 in) and 140 mm (5.5) was applied to maintain the soil moisture status at 40% and 65% FC respectively.

[1]*CSIDC, Outlook*

Table 2. Seed piece spacing effects on 'seed' grade yield for potato cultivars grown under different irrigation regimes.

	Seed grade yield					
	Dryland		40% F.C.[1]		65% F.C.	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Atlantic	44.0	392.6	43.8	390.8	49.8	444.3
Norland	45.9	409.5	50.7	452.3	49.2	439.0
Russet Burbank	42.8	381.9	43.2	385.4	44.0	392.6
Russet Norkotah	47.8	426.5	51.5	459.5	50.8	453.2
Shepody	43.0	383.6	43.3	386.3	42.3	377.4
15 cm spacing	45.8	408.6	48.2	430.0	47.4	422.9
20 cm spacing	46.9	418.4	48.4	731.8	50.1	447.0
30 cm spacing	41.3	368.5	43.0	383.6	44.2	394.4
Analysis of variance						
Cultivar (C)	***(2.4)		***(3.8)		***(4.7)	
Spacing (S)	***(1.9)		***(2.9)		**(3.7)	
C x S	NS		*(6.6)		NS	
CV (%)	6.5		9.9		12.1	

[1]Field Capacity
***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 3. Seed piece spacing effects on 'consumption' grade yield for potato cultivars grown under different irrigation regimes.

	Consumption grade yield					
	Dryland		40% F.C.[1]		65% F.C.	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Atlantic	33.9	302.5	35.5	316.7	41.2	367.6
Norland	35.2	314.1	41.6	371.2	41.9	373.8
Russet Burbank	26.2	233.8	29.4	262.3	30.4	281.2
Russet Norkotah	36.0	321.2	41.2	367.6	40.3	359.6
Shepody	36.2	323.0	38.7	345.3	38.2	340.8
15 cm spacing	32.3	288.2	36.4	324.8	36.5	325.7
20 cm spacing	35.2	314.1	39.1	348.9	41.6	371.2
30 cm spacing	32.9	293.5	36.3	323.9	37.1	331.0
Analyses of Variance						
Cultivar (C)	***(2.8)		***(4.1)		***(4.7)	
Spacing (S)	*(2.2)		NS		*(3.6)	
C x S	*(4.8)		NS		NS	
CV (%)	10.1		13.5		14.7	

[1]Field Capacity
***, *, and NS indicate significance at P<0.001, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

The abundant precipitation during the 1999 growing season resulted in above average yields under dryland conditions. Dryland production on the average produced 44.7 t/ha (399 Cwt/ac) 'seed' grade yield and 33.5 t/ha (299 Cwt/ac) 'consumption' grade yield (Tables 2 and 3). Soil maintained at 40% FC produced 4% higher 'seed' grade yield and 11% higher 'consumption' grade yield than dryland. The soil maintained at 65% FC produced 2% higher 'seed' grade yield and 3% higher 'consumption grade yield relative to the soil maintained at 40% FC.

Russet Norkotah potato produced the highest and Shepody the lowest 'seed' grade under all moisture regimes (Table 2). Shepody produced the highest 'consumption' grade yield under dryland and Norland produced the highest 'consumption' grade yield under 40% and 65% FC (Table 3).

The widest seed piece spacing (30 cm; 12 in) produced the lowest 'seed' grade yield under all moisture regimes (Table 2). Increasing plant populations by reducing the within-row spacing to 20 cm (8 in) produced 13%-14% higher 'seed' grade yield than the 30 cm (12 in) spacing. Tighter planting by reducing the within-row spacing to 15 cm (6 in) tended to reduce 'seed' grade yield slightly compared to a seed piece spacing of 20 cm (8 in) at all moisture regimes (Table 2). Maximum 'consumption' grade yield was obtained for the mid seed piece spacing of 20 cm (8 in) relative to the highest and the lowest seed piece spacing (Table 3).

The cultivar x seed piece spacing interaction were significant for 'seed' grade yield under 40% FC (Table 2) and for 'consumption' grade yield under dryland (Table 3).

Figure 1A describes the 'seed' grade yield response for potato grown under 40% FC. The yield for Atlantic and Norland decreased with increase in seed piece spacing. By contrast, the yield for Russet Burbank increased slightly with increase in spacing. Shepody and Russet Norkotah produced the highest 'seed' grade yield at the 20 cm (8 in) spacing compared to the higher and the lower spacings tested. Figure 1B describes the yield response for 'consumption' grade yield under dryland. With increase in seed piece spacing, the 'consumption' grade yield decreased for Norland and increased for Russet Burbank. Atlantic, Shepody and Russet Norkotah produced the highest 'consumption' grade yield at the 20 cm (8 in) spacing compared to the higher and the lower spacings.

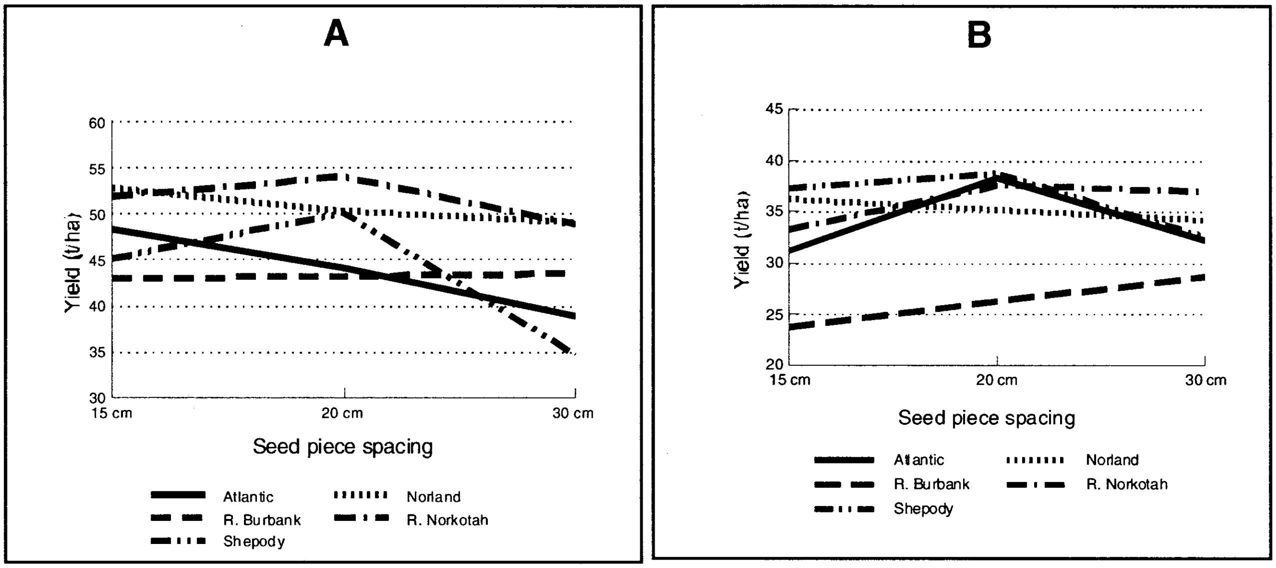


Figure 1. Interactive effects of cultivar and seed piece spacing for 'seed' grade yield under 40% FC (**A**) and 'consumption' grade yield under dryland (**B**).

The tuber specific gravity was higher in the dryland test compared to the irrigated tests. Norland (table potato) had the lowest specific gravity, while Atlantic (chipping potato) recorded the highest tuber specific gravity under the various moisture regimes (Table 4). All the commercial processing cultivars produced acceptable tuber specific gravity under all moisture regimes. Seed piece spacing had no effect on tuber specific gravity (Table 4). All potato cultivars produced relatively darker coloured fries regardless of the soil moisture status under which the crop was produced (Table 4). There was no identifiable trend between fry colour and tuber specific gravity.

Table 4. Seed piece spacing effects on tuber specific gravity and fry color for potato cultivars grown under different irrigation regimes.

Treatment	Dryland		40% F.C.		65% F.C.	
	Specific Gravity	Fry Color	Specific Gravity	Fry Color	Specific Gravity	Fry Color
Cultivar						
Atlantic	1.1015	5	1.0920	4	1.0892	5
Norland	1.0758	4	1.0687	3	1.0673	2
Russet Burbank	1.0853	4	1.0822	3	1.0818	4
Russet Norkotah	1.0843	2	1.0809	2	1.0768	3
Shepody	1.0815	3	1.0748	3	1.0712	2
Spacing						
15 cm	1.0851	3	1.0796	3	1.0775	3
20 cm	1.0888	3	1.0799	3	1.0782	3
30 cm	1.0831	3	1.0796	3	1.0760	3
Analyses of Variance						
Cultivar (C) Spacing (S) C x S	***(0.006) NS NS		***(0.003) NS NS		***(0.005) NS NS	
CV (%)	0.67		0.39		0.59	

*** and NS indicate significance at P<0.001 level of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Agronomic Studies

J. Wahab[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Nitrogen, Phosphorus and Spacing Study

Nitrogen and phosphorus are the two most limiting nutrients for potato production. Careful management of these elements is essential to optimize yield and to maintain superior tuber quality for all potato market classes. Nitrogen management is particularly important for processing potato under the relatively cool and short growing seasons in Saskatchewan. For example, nitrogen deficiency or excess can be detrimental to both yield and quality. Previous studies at CSIDC have shown differential cultivar response to nitrogen and phosphorus application.

This study examined the effects of four levels of applied nitrogen (50, 100, 150, 200 kg N/ha; 45, 90, 135, 180 lb N/ac), two levels of phosphorus (60, 120 kg P_2O_5/ha; 55, 110 lb P_2O_5/ac) and two within-row spacings (15, 30 cm; 6, 12 in) for Russet Norkotah, Ranger Russet, and Shepody potato. Spring soil analysis results for the various tests are summarized in Table 5.

Table 5. Spring soil nutrient levels at 30 cm (12 in) depth for the different nitrogen x phosphorus tests.

Nutrient	Shepody	Range Russet	Russet Norkotah
	Nutient Level kg/ha (lb/ac)		
Nitrogen (N)	37 (33)	44 (39)	54 (48)
Phosphorus (P)	16 (14)	24 (21)	28 (25)
Potassium (K)	632 (563)	696 (619)	688 (612)

Nitrogen Effect

Nitrogen application produced higher 'seed' and 'consumption' grade yields for all cultivars. 'Seed' grade yield optimized at 150 kg N/ha (135 lb N/ac) for Shepody, at 100 kg N/ha (90 lb N/ac) for Ranger Russet and at 200 kg N/ha (180 lb N/ac) for Russet Norkotah (Table 6). The 'consumption' grade yield optimized at 150 kg N/ha (135 lb/ac) for Shepody, and at 200 kg N/ha (180 lb N/ac) for Ranger Russet and Russet Norkotah potato (Table 7). The highest benefit to nitrogen application was obtained up to 100 kg N/ha (90 lb N/ac) for all cultivars and both market classes. Nitrogen application in excess of 100 kg N/ha (90 lb N/ac) produced non-significant yield increase for all cultivars.

Table 6. Nitrogen, phosphorus, and seed piece spacing effects on 'seed' grade yield for Shepody, Ranger Russet, and Russet Norkotah potato.

	Seed grade yield					
	Shepody		Russet Burbank		Russet Norkotah	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
50 kg N/ha	45.6	406.8	44.2	394.4	46.6	415.8
100 kg N/ha	50.7	452.3	47.6	424.7	49.8	444.3
150 kg N/ha	52.9	472.0	46.7	416.7	50.0	446.1
200 kg N/ha	51.0	455.0	46.6	415.8	50.2	447.9
60 kg P_2O_5/ha	49.1	438.1	45.1	402.4	49.0	437.2
120 kg P_2O_5/ha	51.0	455.0	47.5	423.8	49.3	439.9
15 cm spacing	52.2	465.7	49.2	439.0	52.3	466.6
30 cm spacing	47.9	427.4	43.4	387.2	46.0	410.4
Analyses of variance						
Nitrogen (N)	***(2.4)		*(2.1)		**(2.1)	
Phosphorus (P)	*(1.7)		*(1.5)		NS	
Spacing (S)	***(1.7)		***(1.5)		***(1.5)	
N x P	NS		NS		NS	
N x S	NS		NS		***(3.0)	
P x S	NS		NS		NS	
N x P x S	NS		NS		**(4.2)	
CV (%)	6.7		6.3		6.0	

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

[1]*CSIDC, Outlook*

Phosphorus Effect

Applying 120 kg P_2O_5/ha (110 lb P_2O_5/ac) produced significantly higher 'seed' grade yield relative to 60 kg P_2O_5/ha (55 lb P_2O_5/ac) for Shepody and Ranger Russet potato (Table 6). There was no added advantage to higher level of phosphorus application for Russet Norkotah. The 60 kg P_2O_5/ha (55 lb P_2O_5/ac) and 120 kg P_2O_5/ha (110 lb P_2O_5/ac) phosphorus application produced similar 'consumption' grade tuber yields for all cultivars tested (Table 7).

Seed Piece Spacing Effect

Increasing plant population by decreasing seed piece spacing produced significantly higher 'seed' grade yields for all cultivars. This yield advantage was 9% for Shepody, 13% for Ranger Russet, and 14% for Russet Norkotah (Table 6).

Table 7. Nitrogen, phosphorus, and seed piece spacing effect on 'consumption' grade yield for Shepody, Ranger Russet, and Russet Norkotah potato.

	Consumption grade yield					
	Shepody		Ranger Russet		Russet Norkotah	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
50 kg N/ha	38.1	339.9	31.2	278.4	27.8	248.0
100 kg N/ha	44.5	397.0	36.3	323.9	33.4	298.0
150 kg N/ha	47.7	425.6	37.8	337.3	35.6	317.6
200 kg N/ha	46.0	410.4	38.9	347.1	36.8	328.3
60 kg P_2O_5/ha	43.6	389.0	35.4	315.8	33.6	299.8
120 kg P_2O_5/ha	44.5	397.0	36.8	328.3	33.2	296.2
15 cm spacing	44.5	397.0	36.5	325.7	32.1	286.4
30 cm spacing	43.6	389.0	35.6	317.6	34.7	309.6
Analyses of variance						
Nitrogen (N)	***(2.3)		***(2.7)		***(2.5)	
Phosphorus (P)	NS		NS		NS	
Spacing (S)	NS		NS		**(1.8)	
N x P	NS		NS		NS	
N x S	NS		NS		***(3.5)	
P x S	NS		NS		NS	
N x P x S	NS		NS		*(8.5)	
CV (%)	7.3		10.6		8.5	

***, **, *, and NS indicate significance at $P<0.001$, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

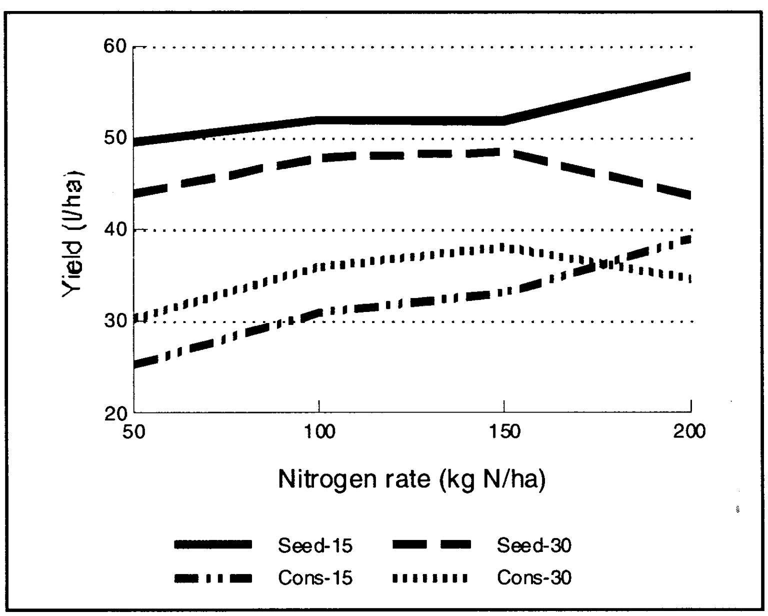


Figure 2. Effects of nitrogen application and seed piece spacing on 'seed' and 'consumption' grade yields for Russet Norkotah.

The 'consumption' grade yields were similar between the two plant populations for Shepody and Ranger Russet (Table 7). For Russet Norkotah, closer spacing (15 cm; 6 in) produced 8% higher 'consumption' grade yield than wider spacing (30 cm; 12 in). The nitrogen x spacing interactions were significant for both 'seed' and 'consumption' grade yields for Russet Norkotah (Tables 6 and 7, Figure 2). For example, for 30 cm (12 in) seed piece spacing both 'seed' and'consumption' grade yields optimized at 150 kg/ha (135 lb/ac) applied nitrogen . By contrast, for 15 cm (6 in) seed piece spacing, both 'seed' and 'consumption' grade yields continued to increase up to 200 kg N/ha (180 lb N/ac).

Processing Quality

Shepody, Ranger Russet, and Russet Norkotah potato produced tubers with superior specific gravity as required by the processing industry. Increased nitrogen application lowered tuber specific gravity (Table 8). However, the specific gravity ranges were within acceptable limits for french fry production. The two phosphorus levels and the two seed piece spacings examined produced tubers with similar specific gravity (Table 8).

The fry colour was relatively darker for the different cultivars or the various treatments (Table 8). Ranger Russet tended to produce darker fries and Russet Norkotah produced lighter fries. There were no identifiable trends between fry colour and the various treatments examined.

Table 8. Nitrogen, phosphorous, and seed piece spacing effect on tuber specific gravity and fry color for Shepody, Ranger Russet, and Russet Norkotah potatoes.

	Shepody		Ranger Russet		Russet Norkotah	
Treatment	Specific Gravity	Fry Color	Specific Gravity	Fry Color	Specific Gravity	Fry Color
50 kg N/ha	1.0954	3	1.0941	3	1.0886	3
100 kg N/ha	1.0937	3	1.0985	3	1.0842	2
150 kg N/ha	1.0903	3	1.0922	4	1.0872	2
200 kg N/ha	1.0870	3	1.0909	4	1.0848	2
60 kg P_2O_5/ha	1.0905	3	1.0951	3	1.0874	2
120 kg P_2O_5/ha	1.0927	3	1.0927	4	1.0851	3
15 cm	1.0908	-	1.0942	-	1.0879	-
30 cm	1.0924	3	1.0937	4	1.0846	2
Analyses of Variance						
Nitrogen (N)	**(0.009)		**(0.009)		**(0.008)	
Phosphorous (P)	NS		NS		NS	
Spacing (S)	NS		NS		NS	
N x P	NS		*(0.006)		NS	
N x S	NS		*(0.006)		NS	
P x S	NS		NS		NS	
N x P x S	NS		NS		NS	
CV (%)	0.58		0.56		0.54	

**, *, and NS indicate significance at P<0.01, 0.05 levels of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Nitrogen Source, Rate, and Timing of Application

Previous studies have shown variable responses to sources of nitrogen fertilizer. It is likely that different cultivars will respond differently to nitrogen source or rate effects. Such information is limited for the Canadian prairies.

Table 9. Spring soil nutrient levels at 30 cm (12 in) depth for the nitrogen source tests.

Nutrient	Norland	Russet Burbank	Russet Norkotah
Nutient Level kg/ha (lb/ac)			
Nitrogen (N)	42 (37)	43 (38)	37 (33)
Phosphorus (P)	15 (13)	10 (9)	13 (12)
Potassium (K)	644 (573)	520 (463)	492 (438)

This study examined the effects of two nitrogen sources (urea, ammonium sulphate), three nitrogen rates (100, 200, 400 kg N/ha; 90, 180, 360 lb N/ac), and two application methods (all at planting, and two equal split applications; at planting and hilling) for Norland, Russet Burbank, and Russet Norkotah potato. Spring soil analysis results for the various tests are summarized in Table 9.

Ammonium sulphate produced higher 'seed' (Table 10) and 'consumption' grade tubers for all cultivars. The increase in 'seed' grade yield by using ammonium sulphate relative to urea was 7% for Norland, 5% for Russet Burbank, and 13% Russet Norkotah (Table10) . The corresponding yield advantages with respect to 'consumption' grade tubers was 8% for Norland, 5% for Russet Burbank, and 14% for Russet Norkotah (Table 11).

The effects of nitrogen rates on 'seed' and 'consumption' grade tuber yields are presented in Table 10 and Table 11, respectively. For Norland, 'seed' and 'consumption' grade yields increased progressively with higher nitrogen rates. Applying 400 kg N/ha (360 lb N/ac) produced 14% higher 'seed' grade yield and 7% higher 'consumption' grade yield than 100 kg N/ha (90 lb N/ac). For Russet Burbank and Russet Norkotah, 200 kg N/ha (180 lb N/ac) appeared to be the optimum for both 'seed' and 'consumption' grade yields.

Applying nitrogen all at planting or split-applied at planting and at hilling produced similar yields (Tables 10 and 11), except for Norland where split application produced significantly (5%) higher 'consumption' grade yield than one application (Table 11).

For Russet Norkotah, the 'seed' and 'consumption' grade yield responses to nitrogen rate were different for the two nitrogen sources, i.e. there was a significant source x rate interaction (Tables 10 and 11). For example, at 100 kg N/ha (90 lb/ac), the 'seed' and 'consumption' grade yields were similar for the two nitrogen sources (Figure 3). However, at high nitrogen levels, eg. 400kg N/ha (360 lb N/ac), ammonium sulphate and urea respond differently. For example, with ammonium sulphate, the tuber yields increase up to 400 kg N/ha (360kg/ac). By contrast, urea tuber yields declined with increase in nitrogen rate up to 400 kg N/ha (360 lb N/ac).

The source of nitrogen fertilizer (ammonium sulphate or urea) or method of application (pre-plant or split-applied) had no effect on tuber specific gravity (Table 12). Higher nitrogen rates produced tubers with lower specific gravity.

Table 10. Nitrogen source, rate, and timing effects on 'seed' grade yield for Norland, Russet Burbank, and Russet Norkotah potato.

Treatment	Seed grade yield					
	Norland		Russet Burbank		Russet Norkotah	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Nitrogen source						
Ammonium sulphate	53.9	480.9	47.8	426.5	53.6	478.2
Urea	50.3	448.8	45.5	406.0	47.4	422.9
Nitrogen rate						
100 kg N/ha	50.6	451.5	45.4	405.1	49.5	441.6
400 kg N/ha	51.6	460.4	48.2	430.0	52.0	463.9
400 kg N/ha	54.1	482.7	46.2	412.2	49.9	445.2
Time of application						
N at Planting	52.2	465.7	46.1	411.3	50.4	449.7
N at Planting & hilling	51.9	463.1	47.2	421.1	50.5	450.6
Analysis of variance						
Nitrogen source (S)	NS		*(2.1)		***(3.6)	
Nitrogen rate (R)	NS		NS		NS	
Time of application (T)	NS		NS		NS	
S x R	NS		NS		*(6.2)	
S x T	NS		NS		NS	
R x T	NS		NS		NS	
S x R x T	NS		NS		NS	
CV (%)	12.2		7.7		12.0	

***, *, and NS indicate significance at $P<0.001$, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 11. Nitrogen source, rate, and timing effects on 'consumption' grade yield for Norland, Russet Burbank, and Russet Norkotah potatoes.

Treatment	Consumption grade yield					
	Norland		Russet Burbank		Russet Norkotah	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Nitrogen source						
Ammonium sulphate	49.9	445.2	38.9	347.1	43.9	391.7
Urea	46.4	414.0	37.2	331.9	38.5	343.5
Nitrogen rate						
100 kg N/ha	45.3	404.2	35.8	319.4	39.6	353.3
400 kg N/ha	47.7	425.6	39.5	352.4	42.5	379.2
400 kg N/ha	51.4	458.6	39.0	348.0	41.5	370.3
Time of application						
N at Planting	47.1	420.2	37.5	334.6	41.3	368.5
N at Planting & Hilling	49.3	439.9	38.7	345.3	41.1	366.7
Analyses of variance						
Nitrogen source (S)	**(2.2)		NS		**(3.2)	
Nitrogen rate (R)	***(2.7)		**(2.5)		NS	
Time of application (T)	*(2.2)		NS		NS	
S x R	NS		NS		**(5.6)	
S x T	NS		NS		NS	
R x T	**(3.8)		NS		NS	
S x R x T	NS		NS		NS	
CV (%)	7.8		9.1		13.2	

***, **, *, and NS indicate significance at $P<0.001$, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

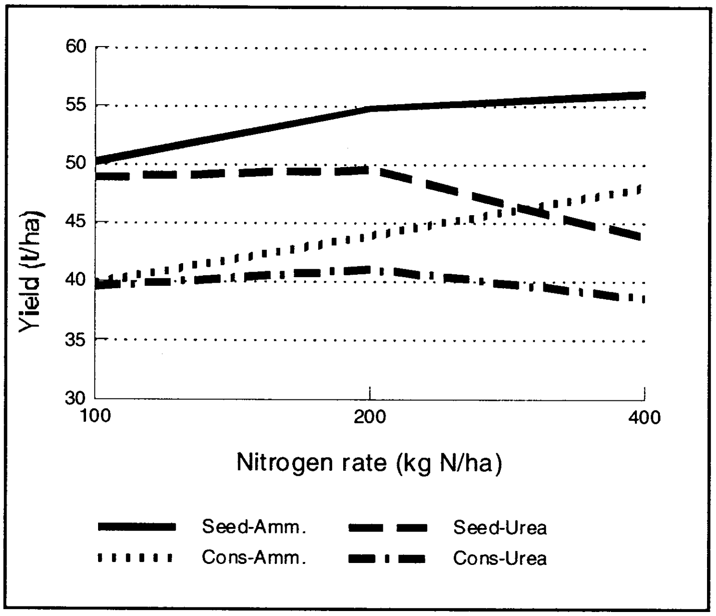


Figure 3. Effects of nitrogen source and rate of application on 'seed' and 'consumption' grade yields for Russet Norkotah.

Table 12. Nitrogen source, rate, and timing effects on tuber specific gravity and fry color for Norland, Russet Burbank, and Russet Norkotah potato.

	Norland		Russet Burbank	Russet Norkotah	
Treatment	Specific Gravity	Fry Color	Specific Gravity	Specific Gravity	Fry Color
Nitrogen source					
Ammonia	1.0710	3	1.0859	1.0829	2
Urea	1.0703	3	1.0845	1.0848	2
Nitrogen rate					
100 kg N/ha	1.0750	3	1.0892	1.0885	2
200 kg N/ha	1.0695	3	1.0849	1.0829	3
400 kg N/ha	1.0675	3	1.0815	1.0802	2
Time of application					
Planting	1.0706	3	1.0845	1.0836	2
Planting+Hilling	1.0707	3	1.0859	1.0841	2
Analyses of Variance					
N source (S)	NS		NS	NS	
N rate (R)	***(0.005)		***(0.005)	**(0.010)	
Timing (T)	NS		NS	NS	
S x R	NS		NS	NS	
S x T	NS		NS	NS	
R x T	NS		NS	NS	
S x R x T	NS		NS	NS	
CV (%)	0.34		0.34	0.63	

***, **, and NS indicate significance at $P<0.001$, 0.01 levels of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Split Application of Nitrogen

Careful nitrogen management is essential for potato production under the short Saskatchewan growing conditions. Rate and timing of application are important considerations to optimize yields and to maintain desired tuber quality. It is likely that various cultivars would respond differently to rate and timing of nitrogen application.

This study examined the effects split-applying different rates of nitrogen (urea) on productivity and tuber specific gravity for Russet Norkotah, Ranger Russet, and Shepody potato. The nitrogen treatments included three rates (150, 200, 400 kg N/ha; 135, 180, 360 lb N/ac) applied at (i) all at planting, (ii) at planting and hilling, (iii) planting, hilling and three weeks after hilling, and (iv) planting, hilling, three weeks after hilling, and two weeks later. Spring soil analysis at the test site indicated 69 kg N/ha (61 lb N/ac), 18 kg P/ha (16 lb P/ac), and 904 kg K/ha (805 lb K/ac) to a depth of 30 cm (12 in).

Shepody produced highest and Russet Norkotah the lowest 'seed' and 'consumption' grade tuber yields (Table 13). The highest yields of both 'seed' and 'consumption' grade tubers was obtained with 150 kg N/ha (135 lb N/ac). Excess nitrogen tended to reduce tuber yields for both market classes and to lower tuber specific gravity (Table 13).

Split application of nitrogen had no effect on 'consumption' grade yield. Four equal splits produced the highest 'seed' grade yield and the highest tuber specific gravity (Table 13).

Table 13. Effects of split application of nitrogen on 'seed' and 'consumption' grade tuber yields and tuber specific gravity for Russet Norkotah, Ranger Russet, and Shepody potatoes.

Treatment	Seed grade yield		Consumption grade yield		Specific Gravity
	t/ha	Cwt/ac	t/ha	Cwt/ac	
Russet Norkotah	52.4	467.5	34.1	304.2	1.0759
Ranger Russet	55.3	493.4	43.1	384.5	1.0824
Shepody	61.1	545.1	56.4	503.2	1.0772
150 kg N/ha	58.6	522.8	46.2	412.2	1.0804
200 kg N/ha	55.1	491.6	43.5	388.1	1.0785
400 kg N/ha	55.2	492.5	43.9	391.7	1.0767
P	55.2	492.5	44.8	399.7	1.0778
P+H	56.2	501.4	44.0	392.6	1.0775
P+H+3	55.7	497.0	43.7	389.9	1.0779
P+H+3+2	58.1	518.4	45.6	406.8	1.0808
Analyses of Variance					
Cultivar (C)	***(2.6)		***(3.0)		***(0.003)
Nitrogen (N)	*(2.6)		NS		***(0.004)
Timing (T)	NS		NS		**(0.004)
C x N	NS		NS		**(0.007)
C x T	*(5.1)		NS		NS
N x T	NS		NS		NS
C x N x T	NS		NS		NS
CV (%)	11.3		16.8		

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Nitrogen and Phosphorus Placement Study

Efficient fertilizer uptake by crops depend on the proximity of its placement to the root zone. This is particularly important for crops with limited root growth such as potato.

This study examined the effects of placement (broadcast, side-band) of nitrogen rate (100, 150, 200 kg N/ha; 90, 135, 180 lb N/ac) and phosphorus rate (60, 120 kg P_2O_5/ha; 54, 108 lb P_2O_5/ac) for Norland and Russet Burbank potato grown under irrigation. For the broadcast treatment, the fertilizer was spread evenly in the furrow prior to planting. For side-banding, the fertilizer was placed 5cm (2 in) away and 2.5 (1 in) cm above the seed piece.

Table 14. Nitrogen and phosphorous placement effects on 'seed', and 'consumption' grade tuber yield for Norland and Russet Burbank potato.

	Seed grade yield				Consumption grade yield			
	Norland		Russet Burbank		Norland		Russet Burbank	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Application Method								
Broadcast	45.4	405.1	45.8	408.6	38.9	347.1	25.1	223.9
Side band	49.0	437.2	46.2	412.2	41.9	373.8	25.8	230.2
Nitrogen rate								
100 kg N/ha	44.6	397.9	44.6	397.9	37.2	331.9	23.5	209.7
150 kg N/ha	48.4	431.8	46.5	414.9	41.7	372.0	25.0	223.1
200 kg N/ha	48.6	433.6	46.9	418.4	42.1	375.6	27.9	248.9
Phosphorous rate								
60 kg P_2O_5/ha	46.4	414.0	45.3	404.2	39.5	352.4	24.7	220.4
120 kg P_2O_5/ha	48.1	429.1	46.7	416.7	41.2	367.6	26.2	233.8
Analyses of Variance								
Application (A)	***(1.74)		NS		***(0.88)		NS	
Nitrogen (N)	*(2.13)		NS		**(1.07)		NS	
Phosphorous (P)	NS		NS		NS		NS	
A x N	NS		NS		NS		NS	
A x P	NS		NS		NS		NS	
N x P	NS		NS		NS		NS	
A x N x P	NS		NS		NS		NS	
CV (%)	6.7		8.4		7.9		10.6	

***, **, * and NS indicate significance at $P<0.001$, 0.01, 0.05 levels of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

For Norland, side-banding produced significantly higher 'seed' and 'consumption' grade yields than broadcast application (Table 14). The corresponding yield advantage was 8% for both 'seed' and 'consumption' grade yield. Fertilizer application method had no effect for Russet Burbank potato.

For Norland, application of 150 kg N/ha (135 lb N/ac) produced 9% higher 'seed' grade yield and 12% higher 'consumption' grade yield than 100 kg N/ha (90 lb N/ac) (Table 14). Further increase in nitrogen rate did not result in any yield advantages.

Higher levels of phosphorus application had no effect on tuber yields for both Norland and Russet Burbank.

Potassium Source and Rate Study

Saskatchewan soils are high in potassium. This study examined the requirement of supplementary potassium for production of contrasting french fry cultivars such as Russet Burbank, Ranger Russet, and Shepody. The fertilizer treatments included two potassium sources (potassium chloride, potassium sulphate) and three rates of application (50, 100, 200 kg K_2O/ha,; 45, 90, 180 lb K_2O/ac). Potassium was applied all at planting. Spring soil analysis results for the various tests are summarized in Table 15.

Table 15. Spring soil nutrient levels at 30 cm (12 in) depth for the phosphorus tests.

Nutrient	Shepody	Range Russet	Russet Norkotah
Nutient Level kg/ha (lb/ac)			
Nitrogen (N)	46 (41)	44 (40)	47 (42)
Phosphorus (P)	17 (15)	16 (14)	20 (18)
Potassium (K)	556 (500)	524 (472)	580 (522)

Potassium chloride produced significantly higher 'seed' and 'consumption' grade tuber yields than potassium sulphate for Russet Burbank, while potassium source had no effect on tuber yields for Ranger Russet or Shepody (Tables 16 and 17). For Russet Burbank, the yield advantage for potassium chloride over potassium sulphate was 8%.

All three cultivars responded positively to increase potassium application although the treatment effects reached significant proportion only for 'seed' grade yield with Ranger Russet (Table 16). For Ranger Russet, applying 200 kg K_2O /ha (180 K_2O /ac) produced 11% higher 'seed' grade yield than 50 kg K_2O/ha (45 K_2O /ac).

Table 16. Potassium source and rate effects on 'seed' grade yield for Russet Burbank, Ranger Russet, and Shepody potato.

	Seed grade yield					
	Russet Burbank		Ranger Russet		Shepody	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Potassium source						
Potassium chloride	50.3	448.8	44.1	393.5	42.4	378.3
Potassium sulphate	46.8	417.5	43.9	391.7	45.0	401.5
Potassium rate						
50 kg K_2O/ha	17.2	521.1	41.6	371.2	42.7	381.0
100 kg K_2O/ha	48.5	432.7	44.4	396.1	43.8	390.8
200 kg K_2O/ha	50.1	447.0	46.1	411.3	44.6	397.9
Analysis of Variance						
K source (S)	***(2.2)		NS		NS	
K rate (R)	NS		*(3.4)		NS	
S x R	NS		NS		NS	
CV (%)	5.2		7.3		17.2	

***, *, and NS indicate significance at P<0.001, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 17. Potassium source and rate effects on 'consumption' grade yield for Russet Burbank, Ranger Russet, and Shepody potato.

	Consumption grade yield					
	Russet Burbank		Ranger Russet		Shepody	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Potassium source						
Potassium chloride	38.9	347.1	38.4	342.6	43.6	389.0
Potassium sulphate	34.4	306.9	37.5	334.6	46.3	413.1
Potassium rate						
50 kg K_2O/ha	35.6	317.6	36.0	321.2	43.1	384.5
100 kg K_2O/ha	36.3	323.9	38.2	340.8	44.6	397.9
200 kg K_2O/ha	38.1	339.9	39.7	354.2	47.3	422.0
Analysis of variance						
K source (S)	***(2.0)		NS		NS	
K rate (R)	NS		NS		NS	
S x R	NS		NS		NS	
CV (%)	6.2		8.1		13.9	

*** and NS indicate significance at P<0.001 level of probability and not significant, respectively.
Value within parenthesis is LSD (5%) estimate for the corresponding treatment.

Potassium (rate and source) application had no effect on tuber specific gravity for all three cultivars (Table 18). Shepody produced the lightest coloured fries compared to Russet Burbank or Ranger Russet.

Table 18. Potassium source and rate effects on tuber specific gravity and fry color for Russet Burbank, Ranger Russet, and Shepody potato.

	Russet Burbank		Ranger Russet		Shepody	
Treatment	Specific Gravity	Fry Color	Specific Gravity	Fry Color	Specific Gravity	Fry Color
Potassium source						
Chloride	1.0824	4	1.0849	4	1.0760	2
Sulphate	1.0820	3	1.0813	3	1.0782	2
Potassium rate						
50 kg K_2O/ha	1.0844	3	1.0837	3	1.0764	3
100 kg K_2O/ha	1.0806	4	1.0795	4	1.0774	2
200 kg K_2O/ha	1.0816	4	1.0861	4	1.0775	3
Analyses of Variance						
K type	NS		NS		NS	
K rate	NS		NS		NS	
K type x K rate	*(0.007)		NS		NS	
CV (%)	0.37		0.92		0.39	

* and NS indicate significance at P<0.05 level of probability and not significant, respectively.
Value within parenthesis is LSD (5%) estimate for the corresponding treatment.

Plant Population and Seed Piece Spacing Uniformity Study

In potato production, plant population and the uniformity of seed piece spacing are critical considerations to maximize yields and ensure uniform tuber size distribution. Optimum plant population is a function of the cultivar used and the associated crop production practices including irrigation. Irregular seed spacing can result in highly variable tuber size distribution.

This study examined the effects two plant populations (37,000 and 74,000 seed pieces/ha;15,000 and 30,000 seed pieces/ac) and three spacing-uniformity treatments (coefficients of variation of 0%, 32%, 65% for seed piece spacing variability). Potato seed pieces were spaced at pre-determined intervals to obtain the required variability effects. For example, 0% C.V. contained seed pieces placed at equal distance within the row. The 65% C.V. contained the most irregular seed piece spacings. This study was conducted with Russet Burbank, Russet Norkotah, and Shepody potato under dryland, 40% FC, and 65% soil moisture conditions. Irrigation treatments were applied as described in the previous irrigation study.

The general absence of treatment interactions for the various factors studied indicates that all three cultivars responded similarly to plant population and seed piece spacing effects under the different moisture regimes (Tables 19 and 20).

Irrigated production outyielded dryland production. The 40% FC soil moisture regime produced 13% higher 'seed' grade yield (Table 19) and 21% higher 'consumption' grade yield (Table 20) than dryland production. The 65% FC soil moisture regime produced 15% higher 'seed' grade yield and 34% higher 'consumption grade yield than dryland.

Table19. Effects of plant population and seed piece spacing uniformity on 'seed' grade yield for potato cultivars grown under different irrigation regimes.

	Seed grade yield					
	Dryland		40% F.C.[1]		60% F.C.	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Russet Burbank	40.5	361.3	43.7	389.9	47.3	422.0
Russet Norkotah	41.1	366.7	45.6	406.8	47.6	424.7
Shepody	41.8	372.9	50.3	448.8	47.1	420.2
37,000 hills/ha	38.4	342.6	43.0	383.6	43.3	386.3
74,000 hills/ha	43.9	391.7	50.1	447.0	51.3	457.7
0% seed spacing CV	42.0	374.7	47.6	424.7	48.6	433.6
32% seed spacing CV	41.8	372.9	47.1	420.2	46.8	417.5
65% seed spacing CV	39.6	353.3	45.0	401.5	46.5	414.9
Analyses of variance						
Cultivar (C)	NS		***(2.2)		NS	
Plant population (P)	***(1.9)		***(1.8)		***(3.3)	
Seed spacing CV (CV)	NS		NS		NS	
C x P	NS		NS		NS	
C x CV	NS		NS		NS	
P x CV	NS		NS		NS	
C x P x CV	NS		NS		NS	
CV (%)	9.8		8.2		14.7	

*** and NS indicate significance at P<0.001 level of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 20. Effects of plant population and seed piece spacing uniformity on 'consumption' grade yield for potato cultivars grown under different irrigation regimes.

	Consumption grade yield					
	Dryland		40% F.C.[1]		60% F.C.	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Russet Burbank	25.7	229.3	29.2	260.5	36.9	329.2
Russet Norkotah	27.4	244.5	32.8	292.6	36.0	321.2
Shepody	35.0	312.3	44.6	398.0	45.3	404.2
37,000 hills/ha	28.9	257.8	35.0	312.3	38.1	339.9
74,000 hills/ha	29.8	265.9	36.1	322.1	40.7	363.1
0% seed spacing CV	30.2	269.4	36.6	326.5	40.5	361.3
32% seed spacing CV	29.7	265.0	36.2	323.0	39.1	348.9
65% seed spacing CV	28.3	252.5	33.8	301.6	38.6	344.4
Analyses of variance						
Cultivar (C)	***(2.2)		***(2.4)		***(3.7)	
Plant population (P)	NS		NS		NS	
Seed spacing CV (CV)	NS		NS		NS	
C x P	NS		***(3.4)		NS	
C x CV	NS		NS		NS	
P x CV	NS		NS		NS	
C x P x CV	NS		NS		NS	
CV (%)	12.8		11.7		16.4	

*** and NS indicate significance at P<0.001 levelof probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

The higher plant population produced significantly higher 'seed' grade yield than the lower plant population under all moisture regimes (Table 19). By contrast, the two plant populations tested produced similar 'consumption' grade yields under the various moisture regimes (Table 20).

'Seed' and 'consumption' grade yields decreased (non-significant) slightly with increase in variability of seed piece spacing. Uniform spacing (i.e. 0% C.V.) produced the highest 'seed' and 'consumption' grade tuber yield, whereas the 65% C.V. spacing treatment produced the lowest yields under the various moisture regimes (Tabes 19 and 20). The corresponding yield differences ranged between 5% to 6% for 'seed' grade yield and 5% to 8% for 'consumption grade yield.

Table 21. Cultivar and seed piece spacing effects on 'seed 'and 'consumption' grade yields.

Treatment	Seed grade yield t/ha	Seed grade yield Cwt/ac	Consumption grade yield t/ha	Consumption grade yield Cwt/ac
Cultivar				
Agria	52.3	466.6	50.4	449.7
Fianna	34.3	306.0	26.5	236.4
Penta	45.2	403.3	40.6	362.2
Russet Burbank	43.0	383.6	32.6	290.9
Russet Norkotah	40.1	357.8	34.8	310.5
Shepody	45.9	409.5	46.5	414.9
Spacing				
30 cm	44.6	397.9	39.0	348.0
40 cm	42.3	377.4	38.1	339.9
Analyses of Variance				
Spacing (S)	NS		NS	
Cultivar (C)	***(2.7)		NS	
S x C	NS		***(2.9)	
CV (%)	8.5		10.4	

*** and NS indicate significance at P<0.001 level of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Plant Population Study for European Potato Cultivars

Saskatchewan is becoming a major seed potato exporter to several countries in the world. Some countries favour European cultivars. Agronomic information for growing European potato cultivars is not available for Saskatchewan.

This study is a preliminary investigation to developing cost-effective management practices for selected European potato cultivars. This project examines the effect of seed piece spacing for several Dutch potato cultivars (Agria, Fianna, Penta) in comparison with Russet Burbank, Ranger Russet, and Shepody under irrigated production.

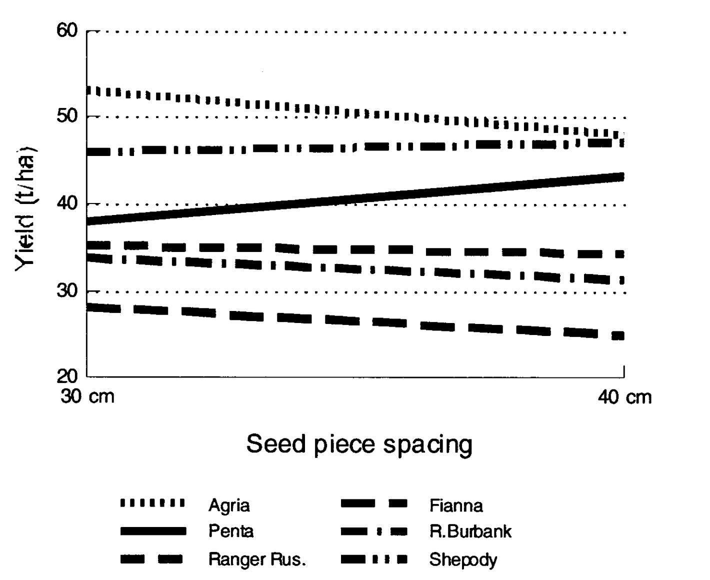


Figure 4. The effect of seed piece spacing on 'consumption' grade tuber yield for different potato cultivars.

Agria and Fianna produced the highest and the lowest 'seed' and 'consumption' grade tuber yields respectively (Table 21). The 30 cm (12 in) and 40 cm (16 in) seed piece spacings produced similar 'seed' grade tuber yields. For 'consumption' grade yield, the various cultivars responded differently to the change in seed piece spacing (Figure 4). With wider pacing the 'consumption' grade yield increased for Penta and Shepody. With the other cultivars, wider spacing resulted in a yield drop.

Effect of Seed Piece Portion on Mainstem Production and Tuber Yield

Table 22. Effect of cultivar and seed piece type on mainstem number, 'seed' grade, and 'consumption' grade yield.

Treatment	Mainstem number per hill	Seed grade yield		Consumption grade yield	
		t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar					
Russet Burbank	2.7	47.9	427.4	36.4	324.8
Russet Norkotah	2.8	45.8	408.6	37.5	334.6
Shepody	2.5	44.8	399.7	44.3	395.2
Type					
Apical+Basal	2.6	46.2	412.2	39.0	348.0
Apical	2.9	47.0	419.3	39.9	356.0
Basal	2.4	45.3	404.2	39.2	349.7
Analyses of Variance					
Cultivar (C)	NS	NS		***(3.4)	
Type (T)	NS	NS		NS	
C x T	NS	NS		NS	
CV (%)	20.1	8.2		10.3	

*** and NS indicate significance at P<0.001 level of probability and not significant, respectively.
Value within parenthesis is LSD (5%) estimate for the corresponding treatments.

In a potato tuber, more eyes are located in the apical end as compared to the mid section or basal end. The apical portion of a potato tuber is likely to develop more mainstems relative to the other parts of the seed-tuber. Potato yield is considered to be a function of mainstem number. Therefore, an apical seed piece is likely to produce higher yields than seed pieces obtained from other parts of a tuber.

This study examined the effects of seed piece type (apical, basal, apical + basal) on the mainstem count and tuber yield for Russet Burbank, Russet Norkotah, and Shepody potato. In the apical + basal seed piece type treatment, equal number of apical and basal seed pieces were mixed for field planting.

Seed piece type had no effect on mainstem number, 'seed', or 'consumption' grade yields (Table 22).

However, the crop planted with only apical seed piece produced slightly higher mainstem number, and tuber yields and the crop established with basal portion alone produced the lowest stem number and tuber yields.

Seed Piece Form and Planting Depth Study

In Saskatchewan, potato is planted into relatively cool soils in the spring. Soil temperatures are even lower at greater depths. Cooler soil temperatures can delay or inhibit emergence leading to seed piece decay, thereby reducing plant stand and affecting yield. It is likely that whole-seed and cut seed-pieces may respond differently with respect to emergence and yield characteristics when planted at different depths.

This study examined the interactive effect of planting depth (15, 22, 30 cm; 6, 9, 12 in) on mainstem production and productivity for Norland, Russet Burbank, Russet Norkotah, and Shepody potato established using whole-seed and cut seed pieces (half) of similar weight.

All cultivars responded alike for seed form and planting depth effects (Table 23).

Planting depth had no effect on mainstem number, 'seed' or 'consumption' grade yields (Table 23).

Half-seed produced significantly higher number of stems and 'seed' grade yield compared to whole seed (Table 23). However, seed form did not affect 'consumption' grade yields.

Haulm Covering Study

Tuber set in potato is a function of the number of stolon developed on a mainstem which is, in turn, determined by the number of buried nodes. It is likely that different cultivars may respond differently with respect to stolon development and tuber yield.

This study examined the effect on mainstem production and tuber yield after covering 5 cm and 10 cm (2 and 4 in) tall haulms with soil as compared to the standard practice. This test was conducted using cultivars with diverse growth habits. The cultivars included Alpha, Atlantic, Norland, Russet Burbank, and Russet Norkotah.

All cultivars responded similarly to haulm covering treatments (Table 24). Haulm covering treatments had no effect on mainstem number or tuber yields (Table 24).

Effects of Soil Moisture Status During Seed Crop Production on Performance of the Progeny

Previous studies have shown conflicting results on the productive capacity of seed potato grown under different soil moisture conditions.

Table 23. Effects of cultivar, seed piece spacing and form on mainstem number, 'seed' and 'consumption' grade yields.

Treatment	Mainstem number per hill	Seed grade yield t/ha	Seed grade yield Cwt/ac	Consumption grade yield t/ha	Consumption grade yield Cwt/ac
Cultivar					
Norland	3.1	45.5	406.0	37.1	331.0
Russet Burbank	3.0	46.5	414.9	33.3	297.1
Russet Norkotah	3.0	46.5	414.9	36.4	324.8
Shepody	2.8	49.7	443.4	48.9	436.3
Seed piece form					
Whole	2.7	45.5	406.0	39.0	348.0
Half	3.2	48.6	433.6	38.8	346.2
Depth					
15 cm	2.8	46.5	414.9	38.2	340.8
22 cm	3.1	47.3	422.0	38.9	347.1
30 cm	2.9	47.4	422.9	39.6	353.3
Analyses of Variance					
Cultivar (C)	NS	*(2.9)		***(3.2)	
Form (F)	***(0.2)	**(2.1)		NS	
Depth (D)	NS	NS		NS	
C x F	NS	NS		NS	
C x D	NS	NS		NS	
F x D	NS	NS		NS	
C x F x D	NS	NS		*(0.7)	
CV (%)	20.1	10.7		14.0	

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Table 24. Effect of covering haulms on mainstem number, 'seed' and 'consumption' grade yields for contrasting potato cultivars.

Treatment	Mainstem number per hill	Seed grade yield t/ha	Seed grade yield Cwt/ac	Consumption grade yield t/ha	Consumption grade yield Cwt/ac
Hilling					
No cover	2.5	42.2	376.5	29.5	263.2
5 cm	2.5	42.8	381.9	31.3	279.3
10 cm	2.6	42.6	380.1	31.2	278.4
Cultivar					
Alpha	3.2	38.6	344.4	16.3	145.4
Atlantic	1.8	41.9	373.8	35.8	319.4
Norland	2.4	37.8	337.3	25.1	223.9
Russet Burbank	2.6	44.5	397.0	32.4	289.1
Russet Norkotah	2.9	51.1	455.9	38.0	339.0
Ranger Russet	2.6	39.3	350.6	28.2	251.6
Shepody	2.4	44.7	398.8	39.0	348.0
Analyses of Variance					
Hilling (H)	NS	NS		NS	
Cultivar (C)	***(0.3)	**(5.1)		***(5.7)	
H x C	NS	NS		NS	
CV (%)	19.6	20.9		31.9	

***, **, and NS indicate significance at P<0.001, 0.01 levels of probability and not significant, respectively.
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

This study examined performance of seed of contrasting potato cultivars (Atlantic, Norland, Russet Burbank, Russet Norkotah, Shepody) produced under different moisture regimes (dryland, 40% FC, 65% FC) and seed piece spacings (15, 20, 30 cm; 6, 8, 12 in). The seed crop was raised in 1998 and the performance was evaluated in the summer of 1999. The moisture condition under which the seed crop was raised and the seed piece spacing utilized to grow the crop had no effect on 'seed' or 'consumption' grade yields (Table 25). All cultivars responded similarly to the agronomic practices used to produce the seed crop on productivity of the progeny.

Effects of Nitrogen and Phosphorus Status During Seed Crop Production on the Performance of the Progeny

It has been reported that the management practices utilized to produce seed potato can influence the performance of the progeny tubers. This includes fertilizer practices. This study examined the performance of Russet Norkotah, Ranger Russet, and Shepody seed potato raised under two nitrogen levels (50, 100 kg N/ha; 45, 90 lb N/ac) and two phosphorus levels (60, 120 kg P_2O_5/ha; 54, 108 lb P_2O_5/ac). The seed crop was grown in 1998 and its performance was evaluated in 1999.

All three cultivars responded similarly to the effects of nitrogen and phosphorus given to the seed crop (Table 26). Seed potato grown using 100 kg N/ha (90 lb N/ac) produced 6% higher 'seed' grade yield

Table 25. Effects of cultivar, irrigation regime, and seed piece spacing on 'seed ' and 'consumption' grade yields of the progeny.

Treatment	Seed grade yield		Consumption grade yield	
	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar				
Atlantic	53.6	478.2	49.4	440.7
Norland	48.0	428.3	42.2	376.5
Russet Burbank	45.5	406.0	33.3	297.1
Russet Norkotah	49.7	443.4	40.2	358.7
Shepody	54.3	484.5	51.8	462.2
Regime				
Dryland	49.2	439.0	43.5	388.1
40% F.C.[1]	50.0	446.1	43.2	385.4
65% F.C.	51.4	458.6	43.6	389.0
Spacing				
15 cm	50.3	448.8	43.0	383.6
20 cm	50.8	453.2	43.9	391.7
30 cm	49.5	441.6	43.3	386.3
Analyses of Variance				
Cultivar (C)	***(2.8)		***(2.8)	
Irrigation (I)	NS		NS	
Spacing (S)	NS		NS	
C x I	NS		NS	
C x S	NS		NS	
I x S	*(3.7)		NS	
C x I x S	NS		NS	
CV (%)	11.9		14.1	

[1]Field Capacity
***, *, and NS indicate significance at P<0.001, 0.05 levels of probability and not significant, respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 26. Nitrogen and phosphorous effects during seed production of different potato cultivars on the performance of the progeny.

Treatment	Seed grade yield		Consumption grade yield	
	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar				
Russet Norkotah	45.7	407.7	33.9	302.5
Ranger Russet	41.7	372.0	30.6	273.0
Shepody	46.9	418.4	43.0	383.6
Nitrogen				
50 kg N/ha	43.5	388.1	34.6	308.7
100 kg N/ha	46.0	410.4	37.1	331.0
Phosphorous				
60 kg P_2O_5/ha	44.0	392.6	35.4	315.8
120 kg P_2O_5/ha	45.5	406.0	36.2	323.0
Analyses of Variance				
Cultivar (C)	**(3.0)		***(3.3)	
Nitrogen (N)	*(2.4)		NS	
Phosphorus (P)	NS		NS	
C x N	NS		NS	
C x P	NS		NS	
N x P	NS		NS	
C x N x P	NS		NS	
CV (%)	9.2		12.9	

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant, respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

and 7% higher 'consumption' grade yield than seed grown using 50 kg N/ha (45 lb N/ac). The phosphorus levels under which the seed crop was grown had no effect on tuber yield although seed grown under higher phosphorus levels produced 2%-3% higher yield than seed grown under lower phosphorus levels (Table 26).

Crop Rotation Studies

Adopting and maintaining a proper crop rotation for managing soil, water, nutrients, weeds, insects, and disease, is the key to raising a successful potato crop. This project is designed to examine (i) the effects of the previous crop on potato, (ii) the influence of crop inputs and management used for potato on the succeeding crop in the rotation, and (iii) interactive effects of cropping sequence, nitrogen, and phosphorous response on potato productivity.

The Effect of the Previous Crop on Potato

This study was designed to examine the effect of productivity when grown on the stubble of different crops. Five potato contrasting potato cultivars (Norland, Russet Burbank, Russet Norkotah, Ranger Russet, Shepody) were evaluated under three nitrogen levels (150, 200, 250 kg N/ha; 135, 180, 225 lb N/ac) and two phosphorus levels (60, 120 kg P_2O_5/ha; 54, 108 lb P_2O_5/ac). The wheat and canola stubble plots were situated side-by-side. Spring soil analysis results for the various tests are summarized in Table 27. The soil test for canola stubble plots indicated higher levels of nitrogen and phosphorus than the wheat stubble.

Table 27. Spring soil nutrient levels at 30 cm (12 in) depth for the nitrogen source tests.

Nutrient	Shepody	Wheat Stubble
	Nutient Level kg/ha (lb/ac)	
Nitrogen (N)	38 (34)	78 (70)
Phosphorus (P)	40 (36)	32 (29)
Potassium (K)	948 (853)	1060 (954)

Statistical analyses showed significant cultivar effects under both canola and wheat stubble, whereas nitrogen (Figure 5A) and phosphorus (Figure 5B) treatments had no effect on tuber yield under both growing conditions.

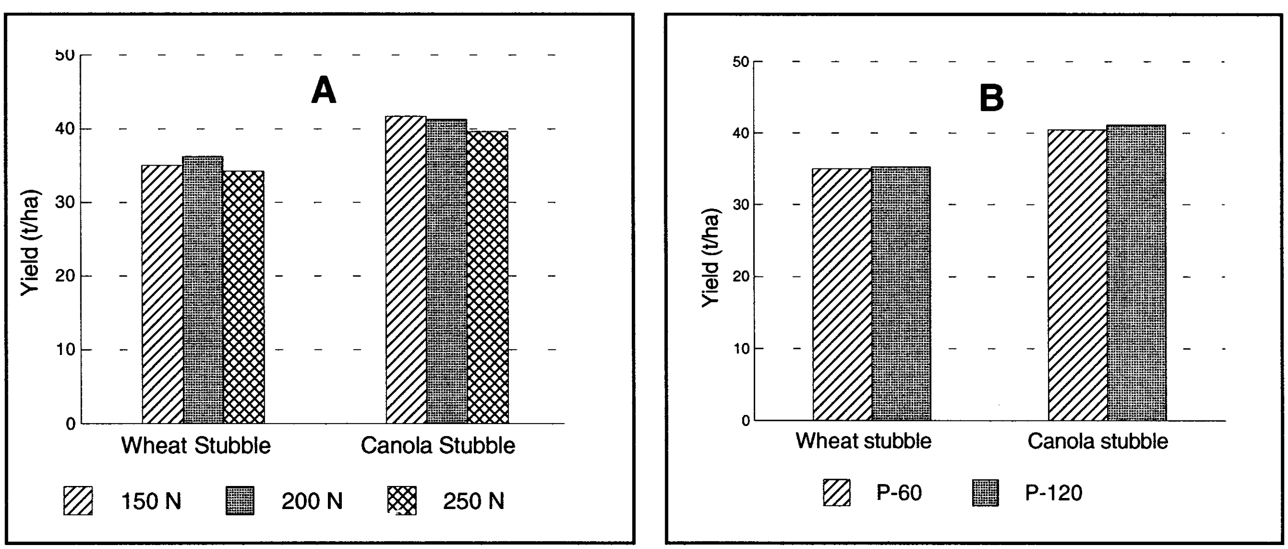


Figure 5. Nitrogen (A) and phosphorus (B) effects on 'consumption' grade potato yield when grown on wheat and canola stubble.

All cultivars produced consistently higher 'consumption' grade yield when grown on canola stubble relative to wheat stubble (Figure 6).

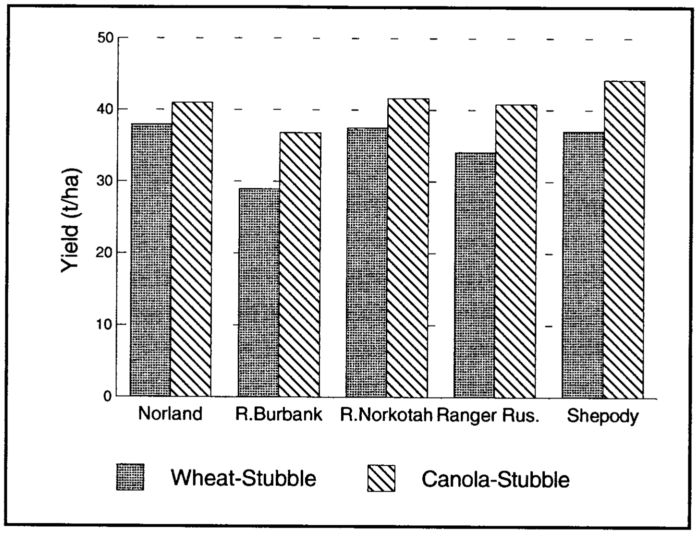


Figure 6. 'Consumption' grade tuber yields for potato cultivars grown on wheat and canola stubble.

Productivity of Crops When Grown After Potato

Potato production requires considerable inputs including nitrogen and phosphorus fertilizer. It is likely that considerable amount of nitrogen and phosphorus may remain in the soil after the potato crop. This study is designed to examine the effect of potato residues on the productivity of other crop in relation to nitrogen (0, 45 kg N/ha, 90 kg N/ha; 0, 41 lb N/ac, 82 lb N/ac) and phosphorus (0, 25 kg P_2O_5/ha; 23 lb P_2O_5/ac) requirement. AC Morse Durum wheat, CDC Camino pinto bean, Carneval field pea, and LG 3295 canola were grown on potato stubble. The spring soil test of the field after potato indicated 35 kg N/ha (32 lb N/ac), 120+ kg P/ha (108+lb P/ac), and 1092 kg K/ha (983 lb k/ac) to 30 cm (12 in) depth.

Durum wheat, pea, and canola grown on potato stubble produced good yields. By contrast the cool wet condition during the summer of 1999 resulted in poor bean yields. The different rates of nitrogen (Figure 7A) and phosphorus (Figure 7B) applied to the various crops did not affect yields. This indicates that durum wheat, dry bean, canola, and field pea can be grown on potato land that supplied 35 kg N/ha (32 lb N/ac), 120+ kg P/ha (108+lb P/ac), and 1092 kg K/ha (983 lb k/ac) to 30 cm (12 in) depth without applying any additional fertilizer.

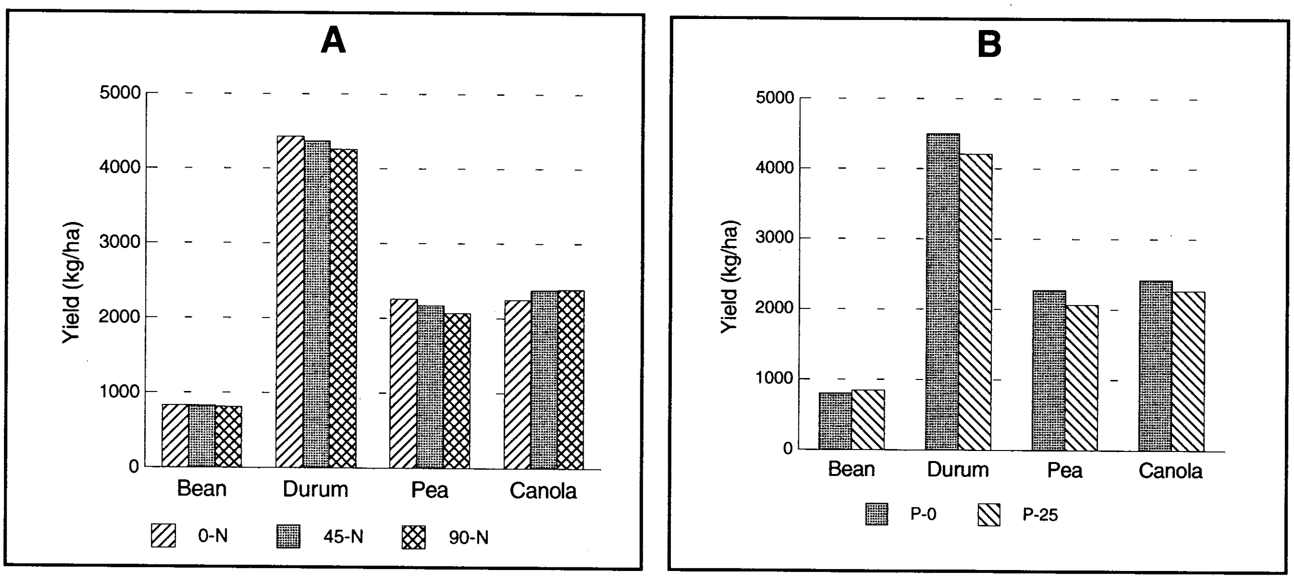


Figure 7. Effects of nitrogen (A) and phosphorus (B) for field crops when grown on potato land.

Horticultural Crops Program

Horticultural Crops Program

Evaluation of Cool Season Vegetable Crops at Three Sites in Saskatchewan

D. Waterer[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Final year of three*

Location: *Saskatoon, Outlook, Nipawin*

Objective: *To evaluate relative earliness, yields, and quality of carrots, cabbage, broccoli, and cauliflower produced at differing locations across central Saskatchewan.*

Outlook

CSIDC Field Research Station
- sandy loam soil
- pH 8.0, E.C. 1.5 dS/m, with minimal shelter

This site is irrigated and has been cropped to vegetables for the last four years.

Saskatoon

Horticulture Field Research Station
- clay soil
- pH 6.9, E.C. <1.0 dS/m, with extensive shelter

This site is irrigated and has been cropped to vegetables for 20 years.

Nipawin

Grindstone Market Gardens (Rod Peterson)
- sandy loam soil
- pH 7.4, E.C. <1.0 dS/m

This site has extensive shelter. Part of this site was irrigated and part was rainfed.

[1] *Dept. of Plant Sciences, U of S, Saskatoon*

Carrot

This trial evaluated the yields and quality of Danvers, Nantes, and Imperator type carrots. Cultivars of each type of carrot were selected for their superior performance in trials previously conducted by the Horticulture Science, Department at the University of Saskatchewan. The crop was seeded in early May at all three sites. Twin rows of each cultivar were seeded 15 cm (6 in) apart in 8 m (2.5 ft) rows replicated three times at each site. Trifluralin was applied pre-plant and Linuron was applied when the crop reached the two true leaf stage. No significant pest or disease problems were observed, except some Aster Yellows at the Nipawin and Saskatoon sites. Overhead irrigation was used to maintain soil water potential above -40 kPa through the growing season. Plots were hand dug and sampled for yield and root quality in the third week of August and again in mid-October. Yields were determined both before and after the roots were graded according to industry standards for size, uniformity, and freedom from defect. Flavour was evaluated at the time of harvest.

Cool, wet conditions in the spring resulted in excellent emergence at all sites. Subsequent crop growth was slow due to lack of heat. However, warmer conditions in August pushed the crop though to maturity. Crop quality appeared excellent at all sites.

Cabbage

This trial evaluated earliness, yields, and quality of cabbage produced at the three test sites. The cultivars were selected based on previous performance in University of Saskatchewan trials and the preference expressed by local processors. At the Nipawin site, direct seeded crop was compared to production utilizing 6 week old transplants. A small observational trial using transplants was also conducted in Outlook and Saskatoon. The direct seeded crop was planted in early May. Twin rows of each cultivar were seeded 1 m (39 in) apart in 8 m (2.5 ft) rows replicated four times at each site. The six week old transplants were placed in adjacent plots at the same time. Trifluralin was used prior to planting at all three sites. Looper pressure was moderate. Cabbage root maggots (*Delia sp.*) were a problem in Outlook, particularly on the transplanted crops. Over head irrigation was used to maintain soil water potential above -40 kPa throughout the growing season. The cabbage was harvested weekly through until mid-October by which time growth had effectively ceased. Heads were graded, weighed, and measured. Density of heads was evaluated on a scale of 0-5, with a score of 5 representing a very dense head.

Favorable moisture and temperature conditions at seeding resulted in excellent stand establishment at all three sites. Transplanting accelerated crop development resulting in earlier and larger yields.

Broccoli

This trial evaluated earliness, yields, and head quality of broccoli produced at the three test sites. The cultivars were selected based on past performance in University trials. The crop was seeded in early May at all three sites. Twin rows of each cultivar were seeded 0.75 m (30 in) apart in 8 m (25 ft) rows. This trial was not replicated. Trifluralin was used prior to planting at all three sites. Looper pressure was light throughout the season and root maggots were not a problem. Overhead irrigation was used to maintain soil water potential above -40 kPa throughout the growing season. The broccoli was harvested weekly through until mid-October by which time growth had effectively ceased. Heads were graded, weighed, and measured.

Favorable moisture and temperature conditions at seeding resulted in excellent stand establishment at all three sites. Steady rain and cool weather slowed crop development but eventually resulted in excellent yields and crop quality at all three test sites.

Cauliflower

This trial evaluated earliness, yields, and head quality of cauliflower produced at the three test sites. The cultivars were selected for the trial based on past performance in University trials. Transplants were evaluated versus the direct seeded crop at all test sites. The crop was seeded in early May. Twin rows of each cultivar were seeded 0.75 m (30 in) apart in 8 m (25 ft) rows. This trial was not replicated. Trifluralin was applied for weed control prior to planting at all three sites. Root maggots caused extensive losses in the transplanted crop in Outlook. Looper pressure was heavy at all three sites throughout the year. However, looper damage had no impact on yields or quality of the cauliflower at any of the test sites. Overhead irrigation was used to maintain soil water potential above -40 kPa throughout the growing season. The cauliflower was harvested weekly through until mid-October by which time growth had effectively ceased. Heads were graded, weighed, and measured.

Unless root maggots can be controlled, use of transplants represents a risk to cauliflower production. One option may be to treat the transplants with an insecticidal drench at transplanting. Transplanting accelerated crop growth and maturity resulting in higher yields and superior head size in 1999.

Commercial Vegetable Production - An Opportunity Awaits

O. Green[1], B. Vestre[2], L. Tollefson[2], H. Clark[2], D. Waterer[3]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Final year of three*

Location: *CSIDC*

Objective:
- To produce selected vegetable crops on a commercial scale to determine suitability for the wholesale and retail markets.
- To determine costs of production and net returns for potential vegetable growers.

Based on unload data, Saskatchewan is 7% self sufficient for "in-season" fresh vegetables. That self-sufficiency compares to 33% in Alberta and 57% in Manitoba.

The 93 % of in-season fresh vegetables imported into this province represent a direct loss of about $20,000,000 to the Saskatchewan economy annually. About 40 to 50 % of that money goes to vegetable growers in other Canadian provinces, primarily Manitoba, while the remainder goes to the United States.

In 1996, the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) commenced a vegetable project to demonstrate newer technologies such as drip irrigation, mulch, mini-tunnels, floating row covers and wind protection. In 1997 and 1998 the Agri-Food Innovation Fund (AFIF) provided funding to carry on the project with eleven vegetable crops.

[1]*Broderick Gardens, Outlook*
[2]*CSIDC, Outlook*
[3]*Dept. of Plant Sciences, U of S, Saskatoon*

The vegetables were grown on approximately 0.2 ha (½ acre) sized blocks to simulate a commercial operation. The crops were harvested, washed, graded, packaged as appropriate, and marketed to wholesale buyers to further simulate commercial production. Data obtained was used to calculate a Saskatchewan-based cost of production for each crop.

IRT (infrared transmissible) mulch was used alone or in combination with mini-tunnels and/or row covering where applicable for the pumpkin, cucumbers, peppers and cantaloupe. To make most efficient use of the mulch, crops were planted in a double row configuration along the outer edge with the drip tape running between the two rows.

Wind protection was provided for pumpkin, cucumbers, cantaloupe and peppers by using rye solid seeded between the mulch rows either in fall or early spring. A waterwheel planter was used for cabbage, peppers, cantaloupe, broccoli, cauliflower, romaine lettuce, Brussels sprouts and celery transplants and for pumpkin and cucumber sown through the mulch. A Stanhay precision seeder was used to direct seed pelleted carrot seed on raised beds.

The Produce was harvested, washed, graded and packed as appropriate and moved to wholesale and / or processing markets. Peppers remaining at season end in1998 were processed and marketed as a frozen diced product.

Field days and tours were held to demonstrate production techniques to interested individuals. Wholesale buyers were invited to similar events to be shown the quality of the crops and to encourage the use of Saskatchewan produce.

In 1997, cumulative corn heat units (CHU) were near average at 2369. 1998 was above normal at 2545 CHU and 1999 was lower at 2077 CHU compared to the long term average of 2253. The heat loving crops pumpkin, cucumbers and peppers performed exceptionally in the warm 1998 season. Cabbage, a cool season crop, performed much better in 1999.

Pumpkin

Pumpkin produced the most impressive results. Yields from 87 to 143 t/ha (38.7 to 63.5 tons/ac) were achieved with an average price of $0.319/kg ($0.145/lb) (Table 1).

The quality of the pumpkin was excellent and well received by wholesale buyers. Most were completely orange in the field. Some late pollinated pumpkin required further ripening but there was little loss due to green colour.

The net returns were positive each year ranging from $7,324/ha ($2,964/ac) to $21,675/ha ($8,772/ac) in 1998. These results have encouraged a number of producer s to grow pumpkin. There is a limited, seasonal, market for pumpkin. Those interested in growing pumpkin should exercise caution.

Carrot

In terms of ease of production, quality, yield, and market demand, carrots were the more attractive option for further development in this project. It is one of the few vegetables for which production can be entirely mechanized.

Bunched carrots (6 to 8 per bunch X 24/case) returned the equivalent of 1740 cases/ha (704 cases/ac) valued at 20,613/ha ($8342/ac) .

Topped carrot yields ranged from 19.6 t/ha (8.7 tons/ac) in 1999 to 57.5 t/ha (25.5 tons/ac) in 1997 (Table 2). The higher yield is indicative of carrot yield potential.

Of the total marketable crop an average of 78% was sold as a Canada No.1 in an 0.9 or 2.3 kg (2 or 5 lb) poly consumer pack while the remainder was moved into the processing market.

The scale of this project did not lend itself to efficiencies in harvest nor in the washing, grading and packaging operation. Consequently, the actual costs did not result in a positive net return. Assuming machine harvest and a washing, grading and packaging line along with good storage, it would appear that net returns in the range of $7412 /ha ($3000/ac) could be achieved.

Cabbage

A comparison of direct seeded cabbage to transplanted crop in the first two years indicated yields of 62.8 t/ha (27.9 tons/ac) for transplants and 18.3 t/ha (8.1 tons/ac) for direct seeding Extra cost incurred by producing transplants were $2000/ha ($800/ac). At an average selling price of $0.246/kg ($0.112/lb), the net return for transplants was $11,000/ha ($4430/ac), which more than covered the additional expense. Transplanted cabbage was harvested about 10 days earlier than direct seeded cabbage. Despite a regular spraying schedule for flea beetles, root maggots and imported cabbage worm, the direct seeded cabbage appeared to suffer greater insect damage than transplants.

The average yield from transplants over the three years of the project was 72 t/ha (32.0 tons/ac). With an average price of $0.246/kg ($0.112/lb), the gross returns were $17,732/ha ($7179/ac) (Table 1).

Peppers

Pepper returns were highly variable and extremely weather dependent. Total heat units affected yield, quality, fruit size, and the proportion of red peppers produced. Overall marketed yields ranged from a low of 340 kg/ha (300 lb/ac) in 1999 to a high of 49200 kg/ha (43667 lb/ac) in 1998 (Table 1a).

Peppers are sold on the basis of size and color. Those not sufficiently sized can be sold as a chopper grade for restaurants and institutions. Red peppers for retail command a premium. The price for peppers ranged from a low of $0.72/kg ($0.327/lb) for green choppers to a high of $2.60/kg ($1.18/lb) for retail red peppers.

The option to make diced frozen peppers from those picked immediately prior to freeze-up was explored in the latter two years of the project. An acceptable product could be achieved. Efficiencies of scale and some degree of mechanization will be required in order to make it economically viable.

Cucumber (slicing)

Cucumber production is a labour intensive. It requires careful picking every two days during the peak harvest period. Moving vines too aggressively during harvest resulted in abrasion damage to young undeveloped fruit that later resulted in scarring. These fruit were not saleable. A solution involved leaving the vines relatively intact while searching for harvestable fruit and removing the cucumbers with minimal vine disturbance.

High harvest costs resulted in low net return. Losses from scarring and marketing difficulties due to temporary surpluses resulted in losses ranging from 20 to 36% of marketed yields.

Marketed yields ranged from 2400 cases/ha (968 cases/ac) (24 count/case) to 5820 cases/ha (2,347 cases/ac). Gross dollar return ranged from $12,500 to 31,500/ha ($5,041 to $12,705/ac) (Table 1a).

Further mechanization in terms of picking aids as well as improved packaging efficiencies would significantly improve the economics of cucumber production.

Commercial Scale Demonstrations

Broccoli

Harvest commenced July 30 and concluded October 8 after a number of frosts. Quality of the heads was still excellent. Large heads allowed the majority of the broccoli to be packed as single heads. Harvesting frequency was critical during early harvests. Slower crop development later in the fall allowed more flexibility in harvest and marketing.

The heads were field trimmed, placed in pallet bins, stored in a filacel cooler and were graded, packed 14 count per case, top iced, and shipped.

In 1999, a yield equivalent to 3043 cases/ha (1232 cases/ac) were marketed at an average price of $10.39/case for a gross return of $31,616/ha ($12,800/ac) (Table 1).

Cauliflower

Cauliflower was harvested early as a 12 count size head rather than a 9 count which allowed a better quality, whiter head to be marketed. Harvest began July 30 and concluded October 12. Frost did not damage the cauliflower, however it was slow to size during late September and early October.

A total of 2380 cases/ha (965 cases/ac) were marketed at an average price of $9.80/case for a total return of $23,363/ha ($9459/ac) (Table1).

Brussels Sprouts

Brussels sprouts requires considerable labour for hand harvesting. The sprouts are difficult to remove and would create some distress to workers with a large area to harvest. The average quantity harvested was 20 kg (40 lb) per person per hour but ranged from 13.5 to 28 kg (30 to 62 lb) per person per hour.

A total of 16,262 kg/ha (14,520 lb/ac) was marketed at an average return of $1.25/kg ($0.557/lb) for a gross return of $19,962/ha ($8082/ac) (Table1). Although the quality of the sprouts was acceptable, variability in size may necessitate a mechanical means of sizing.

The success of this crop will most likely depend on the introduction of some means of mechanical harvest.

Celery

This is a long season crop requiring transplants started in March and field planted in early June after the temperature remains above 10°C (50°F). In addition it is a crop that responds well to good moisture levels throughout the growing period.

The celery harvest began September 8 and concluded October 12 at which time it had been exposed to several frosts. The celery marketed was of high quality with good-sized hearts (both length and diameter). There was little stringiness.

A total of 1280 (24 count) cases/ha (518 cases/ac) equivalent was marketed at an average price of $12.72 per case for a gross of $16,270/ha ($6587/ac) (Table 1). Poor head formation resulted in low yield.

Romaine Lettuce

The bulk of the lettuce harvest originated from the first two sequential plantings. The quality of the lettuce was excellent, with good-sized heads and no tip burn. Lettuce maturing later in the heat of the summer failed to form heads.

The equivalent of 1764 cases (24 count)/ha (714 cases/ac) was marketed at an average price of $8.48 per case giving a gross return of $14,958/ha ($6056/ac) (Table 1). This price compared to $11.99/case received in 1998.

Cantaloupe

An equivalent 1704 cases/ha (690 cases/ac) was marketed at an average price of $12.47 per case for a gross return of $21,252/ha ($8600/ac) (Table 1).

Consumers continue to be impressed with the quality of cantaloupe picked at or close to full slip. Sugar content of this cantaloupe was as high as 13%, but normally ranged from 9 to 12%. Sugar content of imported cantaloupe harvested several days prior to full slip to accommodate shipping is about half full slip fruit. Locally grown cantaloupe is essentially identical to imported produce in appearance. Effective promotion will be essential to command a premium for this superior quality.

Conclusion

Labour

Labour was the most significant cost associated with vegetable production in this project. Labour ranged from of 33% of the total variable costs (pumpkin) to 63% (romaine lettuce). The average of all crops was 49%.

Mechanization and efficient operating systems is the most important requirement to improve economic returns for commercial operations. Managing the human resource by selecting and motivating suitable employees, and by rewarding productivity to assure efficient operations is also important.

Costs of Production

A detailed cost of production analysis for each of the three years along with an average and a projection for each crop is available. The projected cost of production for each crop reflects an estimation of what a commercial operation should reasonably expect in terms of yields, costs and returns.

These data indicate that pumpkin production would provide the best net return of the crops grown in this project. Caution is advised as the pumpkin market is limited and highly seasonal. Carrot and cabbage present the next best alternative on the basis of these results.

Pepper production is more dependent on warmer weather compared to other crops grown in this project. Caution is advised until longer-term experience can be accumulated, or newer technologies, such as the high tunnel, can be evaluated further. The option to profitably process peppers into a diced frozen product during or at the end of the season would reduce marketing risk.

Labour costs associated with cucumber harvesting made this crop the least attractive of the crops in this project. The challenge to grow slicing cucumbers commercially would be to devise a harvesting procedure or system that would reduce this cost.

Saskatchewan Grown

Acceptable yields of high quality produce can be grown in Saskatchewan. Superior quality produce can be offered to the trade where proximity to market allows timely harvest and delivery. Net returns have been positive for the most part. Since labour is such a significant component of variable costs, productive and efficient use of labour can be critical.

This project has resulted in additional private production, particularly pumpkin. A new generation co-operative is being formed to further develop the vegetable industry by coordinating marketing to the wholesale / retail and processing market.

The Canada food guide recommends the consumption of five to ten servings of fruits and vegetables per day for a healthy diet. Why not make it **SASK GROWN?**

Table 1. Average yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 1999, SI units.

Crop	Mean yield (kg/ha)		Mean selling price ($/kg)	Gross return ($/ha)	Projected net return ($/ha)
Pumpkin	109,473		0.321	34,943	19,575
Carrot	40,498		0.498	18,841	1781
Cabbage	71,792		0.247	17,668	3858
Pepper	25,249		1.092	25,110	4490
Brussels Sprouts	16,262		1.23	19,963	1593
	Mean yield (cases/ha)	#/case	Mean selling price ($/case)	Gross return ($/ha)	Projected net return ($/ha)
Cucumber	4604	24	5.38	24,960	3401
Broccoli*	3043	14	10.39	31,616	10,498
Cauliflower*	2384	12	9.80	23,364	1494
Romaine Lettuce*	1764	24	8.49	14,958	(2151)
Celery*	1279	24	12.75	16,270	(3584)
Cantaloupe*	1704	9 - 23	12.47	21,252	914

*1999 only

Table 1a. Average yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 1999, Imperial units.

Crop	Mean yield (lb/ac)		Mean selling price ($/lb)	Gross return ($/ac)	Projected net return ($/ac)
Pumpkin	97,740		0.146	14,150	7930
Carrot	36,160		0.222	7630	720
Cabbage	64,100		0.122	7150	1560
Pepper	22,540		0.495	10,170	1820
Brussels Sprouts*	14,520		0.560	8080	650
	Mean yield (cases/ac)	#/case	Mean selling price ($/case)	Gross return ($/ac)	Projected net return ($/ac)
Cucumber	1865	24	5.38	10,100	1380
Broccoli*	1230	14	10.39	12,800	4250
Cauliflower*	965	12	9.80	6060	600
Romaine Lettuce*	715	24	8.49	8080	(870)
Celery*	520	24	12.75	6590	(1450)
Cantaloupe*	690	9 - 23	12.47	8600	370

*1999 only

Table 2. Range in yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 1999, SI units.

Crop	Mean yield (kg/ha)		Mean selling price ($/kg)		Gross return ($/ha)		Projected net return ($/ha)	
	Low	High	Low	High	Low	High	Low	High
Pumpkin	86,690	142,180	0.294	0.341	28,770	42,190	7350	21,750
Carrot	19,570	57,200	0.462	0.524	10,320	24,520	(1990)	3840
Cabbage	56,190	90,280	0.220	0.286	10,690	16,680	2640	5620
Pepper	25,250	48,900	1.00	1.25	345	48,620	(14,120)	22,150
	Mean yield (24 ct cases/ha)		Mean selling price ($/case)		Gross return ($/ha)		Projected net return ($/ha)	
	Low	High	Low	High	Low	High	Low	High
Cucumber	2400	5820	5.20	5.58	12,500	31,510	(3910)	7470

Table 2a. Range in yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 1999, Imperial units.

Crop	Mean yield (lb/ac)		Mean selling price ($/lb)		Gross return ($/ac)		Projected net return ($/ac)	
	Low	High	Low	High	Low	High	Low	High
Pumpkin	77,400	126,950	0.134	0.155	11,600	17,010	2960	8770
Carrot	17,470	51,070	0.210	0.238	4160	9890	(800)	1550
Cabbage	50,170	80,610	0.100	0.130	4310	6730	1070	2270
Pepper	300	43,670	0.454	0.570	140	19,600	(5690)	8930
	Mean yield (24 ct cases/ac)		Mean selling price ($/case)		Gross return ($/ac)		Projected net return ($/ac)	
	Low	High	Low	High	Low	High	Low	High
Cucumber	970	2350	5.20	5.58	5040	12,700	(1580)	3010

High Tunnel Demonstration

D. Waterer[1], B. Vestre[2]

Funded by theCanada-Saskatchewan Agri-Food Innovation Fund (AFIF)

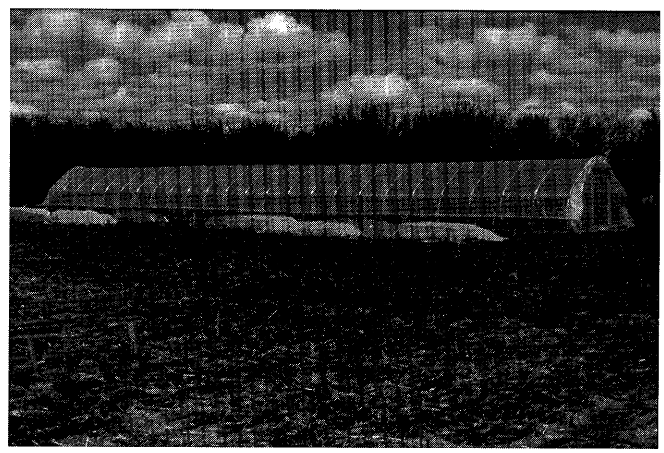
***Progress:** Final year of three*

***Objective:** To evaluate high tunnel growing systems for high value horticultural crops under Saskatchewan growing conditions.*

High Tunnels

High tunnels are similar to low tunnels in design and function, except that; a) one high tunnel covers several rows, b) the high tunnels are wide enough to allow crop growth to full maturity under the tunnels and c) the tunnels are tall enough to allow spraying, cultivation and crop harvest with the tunnels intact.

Typically high tunnels are 5 m (16 ft) wide and 2.5 m (8 ft) high with the length determined by the field dimensions. The structure consists of aluminum arch ribs driven into the ground covered with 6 mil polyethylene. There are no active heating or cooling systems. Rolling up the sides and/or opening the end doors provide both ventilation and access to the crop by pollinating insects.



Exterior and interior of high tunnel structure.

The initial costs of materials and installation of high tunnels are considerably higher than traditional low tunnels. However, the economics of production with high tunnels may still be favourable if they increase yields, they enhance earliness resulting in greater market access at a time when prices are at a premium, and the high tunnels are durable enough to be used for several seasons, thereby amortizing the costs of materials and installation over a greater length of time.

High tunnel trials have been conducted at the Horticulture Science Field Research Station in Saskatoon and at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC), Outlook in 1998 and 1999. Muskmelons, peppers and tomatoes were tested in Saskatoon. Melons and peppers were tested in Outlook. All crops

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were transplanted. Plants in the standard management plots were covered from transplanting until early July by tunnels constructed using clear perforated polyethylene for melons or spun bonded polyester for peppers. The tomatoes were not covered. The crops were harvested twice weekly once fruit reached maturity. Fruit were counted, weighed and graded for acceptability based on locally accepted standards.

Harvesting of crops grown under standard management continued until the first killing frost at which time all remaining fruit was harvested. Harvesting in the high tunnel was terminated once cold temperatures or senescence effectively ceased fruit production. The 1999 growing season was much cooler than in 1998. The first frost was 2 weeks earlier in 1999 than in 1998.

High Tunnel Structure - At the end of the second growing season, the structure at the Saskatoon site was still in good condition with no tears or obvious deterioration of the main plastic cover.

Management - Air temperatures within the high tunnels were somewhat lower than the temperatures recorded inside the standard low tunnels. Consequently, the crop under the low tunnel developed as quickly in the spring as the crop in the high tunnel. Only after the low tunnels had to be removed due to crowding did the high tunnel produce a significant growth advantage. Staking the tomato plants represented an effective means of increasing planting density in the high tunnel. No problems with insects were observed in the high tunnels, but mice thrived in the warm sheltered conditions of the high tunnel. The high tunnel only provided about 3°C of frost protection - suggesting limited potential for extension of the growing season.

Melons

Saskatoon

Crop development was more rapid in 1998 than in 1999, resulting in substantial differences in yields. In both years, the first fruit matured 2-3 weeks earlier in the high tunnel than in the standard treatments. In 1998, mature fruit yield of cv. Earligold was 23% higher in the high tunnel than in the standard treatment. In 1999, the high tunnel out-yielded the standard tunnels by a factor of 4 fold. Fruit flavor and sugar content were comparable for fruit produced either inside or outside the high tunnel.

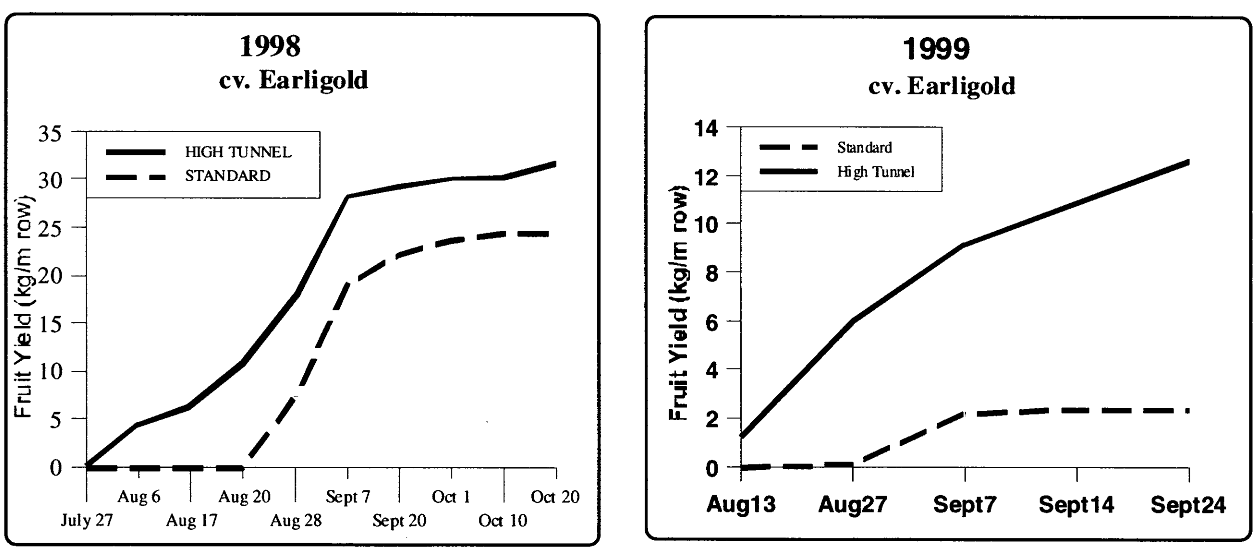

Figure 1. Yield of Earligold melon in a high tunnel as compared to standard practice at Saskatoon, Saskatchewan, 1998 and 1999.

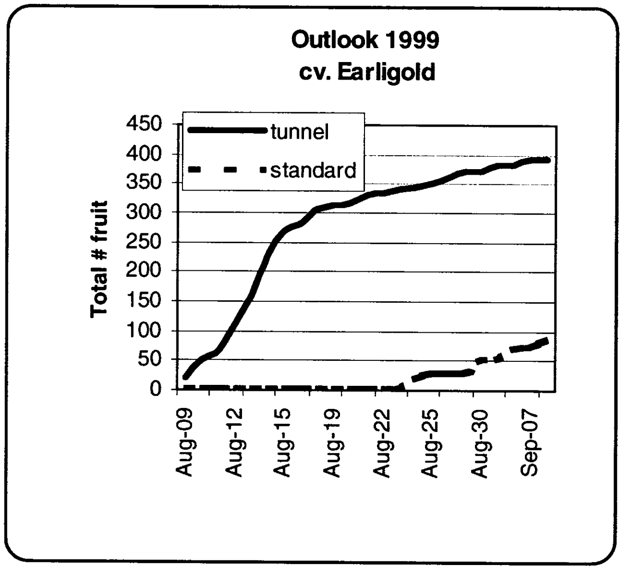

Figure 2. Yield of Earligold melon in a high tunnel as compared to standard practice at CSIDC, 1999.

Outlook

Similar results were obtained in Outlook (Figure 2). The first cantaloupe were harvested on August 9 from the tunnel and on August 27 from the outside plots. The yield inside the tunnel was equivalent to 5360 cases/ha (2170 cases/ac) while the yield from the standard test strips was equivalent to 583 and 761 cases/ha (236 and 308 cases/ac) respectively. The marketed cantaloupe yield from the high tunnel was three times greater than the highest yielding standard treatment. The 9, 12, 15, 18, and 32 count cases made up 20%, 39%, 25%, 13%, and 4% of the fruit respectively.

Tomatoes

Saskatoon

Flowering was first noted two weeks earlier inside the high tunnel than in the standard management regime. Fruit set and fruit quality were excellent inside the high tunnel. In both years, first fruit matured 2-3 weeks earlier in the high tunnel than in the standard treatment. Only a small fraction of the fruit set in the standard production system matured prior to the first frost in either year. Plants in the high tunnel were largely unaffected by frost through October. Total yields (weight) of mature fruit of cv. Spitfire were 33% greater in the high tunnel than for the standard treatment in 1998. In 1999, yields of mature fruit in the high tunnel were 200% greater than outside. Fruit taste and overall appearance was comparable inside or outside the high tunnel. The incidence of fruit rot was lower inside the tunnel than outside. At the termination of the trial there were still substantial numbers of immature fruit on plants growing inside the high tunnel. Total yields (mature + immature) were only slightly higher inside the high tunnel than in the standard management regime.

Peppers

Saskatoon

In 1998, the pepper plants inside the high tunnel at the Saskatoon site were slow growing, chlorotic and brittle throughout the season. No definitive cause of this problem could be determined. In 1999, the crop inside the high tunnel appeared more vigorous throughout the growing season. The first fruit matured 2-3 weeks earlier in the high tunnel than in the standard treatment. In 1998, mature fruit yield for cv Staddon's Select was 73% greater in the high tunnel than the standard treatment. In 1999, no fruit matured outside of the high tunnel, while yields of mature fruit inside the high tunnel were excellent. Average fruit size and overall appearance were comparable for fruit produced either inside or outside the high tunnel. At the termination of the trial, there were still some immature fruit on the plants both inside and outside the high tunnel. With these fruit included in the total yields, the high tunnel produced a 68% yield advantage over the standard tunnel treatment.

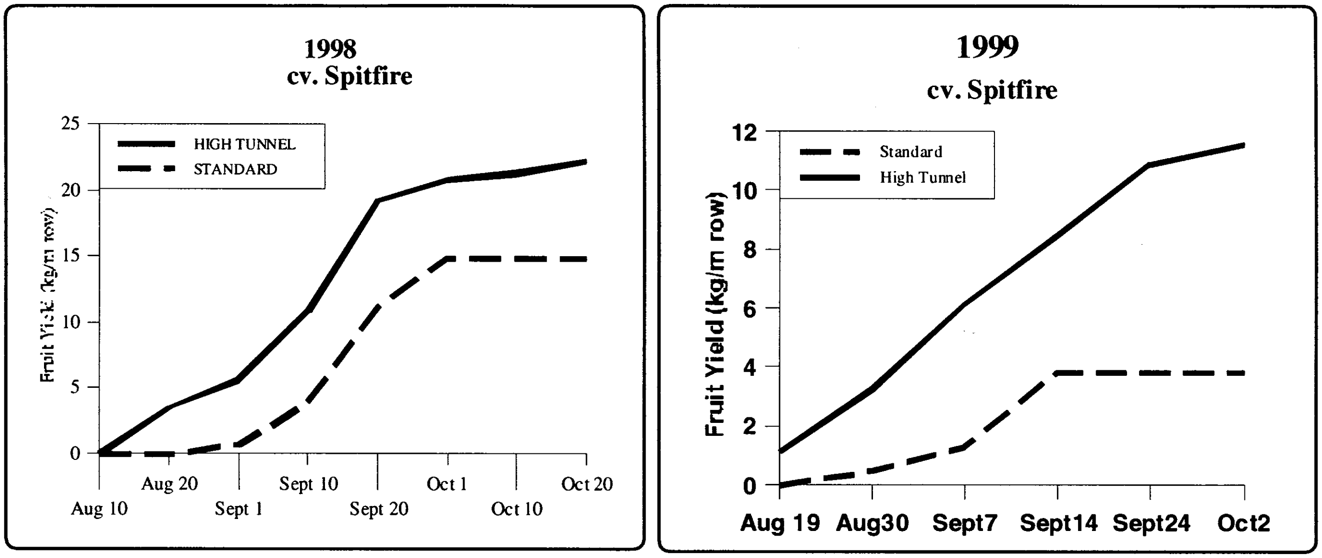

Figure 3. Yield of Spitfire tomato in a high tunnel as compared to standard practice at Saskatoon, Saskatchewnan, 1998 and 1999.

Outlook

Fruit in the tunnel sized approximately 10 days earlier than that from the standard treatment. Yields from the tunnels are shown in Table 1.

The standard treatment yield was equivalent to 15,330 kg/ha (13,680 lb/ac). There were no red peppers harvested from the standard treatment. Only 30% of the green peppers harvested from the standard treatment made market grade. on average, yield within the high tunnel was more than 3 times greater than the standard treatment.

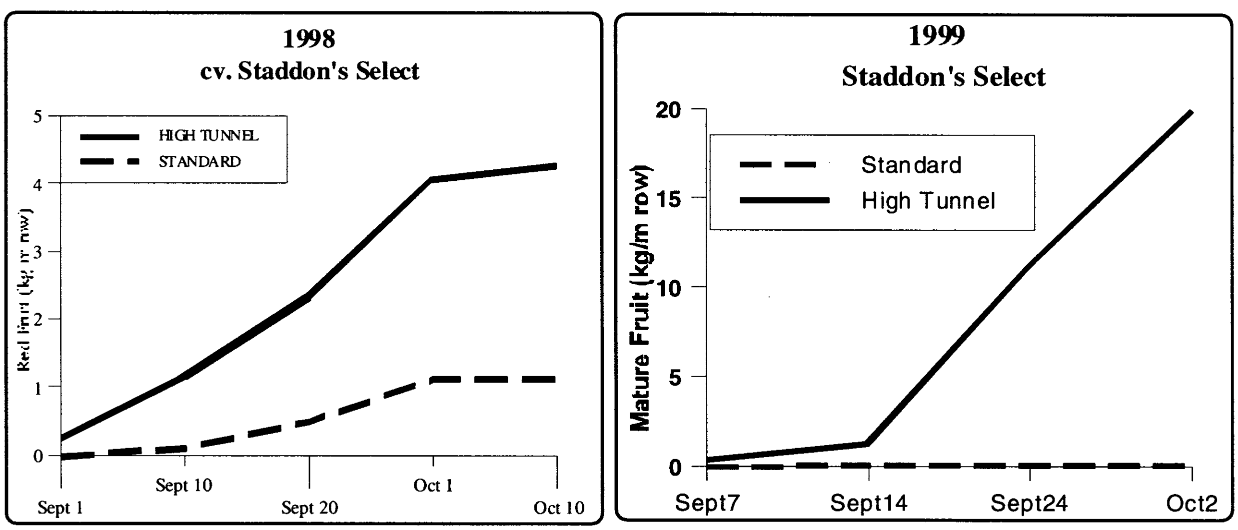

Figure 4. Yield of Staddon's Select peppers in a high tunnel as compared to standard practice at Saskatoon, Saskatchewnan, 1998 and 1999.

Table 1. High tunnel pepper yield, Outlook, 1999					
Cultivar	Fruit Yield kg/ha	Fruit Yield lb/ac	% Red retail	% Green retail	% Green chopper
Valencia	66,815	59,655	40	60	
Ultraset	49,565	44,255	58	13	29
Whopper	22,075	19,710	100		
Superset	56,350	50,310	68	32	

Conclusion

The 1998 growing season was exceptionally favorable which tended to minimize the benefits of micro-climate modification systems, such as the high tunnel. The 1999 cropping season was more representative of a "normal" summer in terms of the average temperatures and the duration of the frost-free season. Under these more "typical" conditions, the high tunnels were more beneficial compared to the warmer 1998 season. In the 1998 season, the high tunnels had accelerated crop development but had provided little real yield advantage. In 1999, the yield advantages obtained using the high tunnels were large and consistent. In some cases, the crops grown utilizing standard plasticulture methods actually failed to produce any marketable yield prior to the first killing frost. In a "normal" Saskatchewan growing season, using the somewhat more costly high tunnels would clearly represent a lower risk and potentially more cost-effective means of producing high-value, warm season vegetable crops.

Cultivar Evaluation Trials and New Cultivar Development for Native Fruit Species

R. St-Pierre[1], L. Tollefson[2], B. Schroeder[3]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Ongoing*

Location: *CSIDC, Outlook*
PFRA, Indian Head
Yorkton

Objective:
- To collect agronomic and fruit quality data from previously established cultivar trials.
- To evaluate and select new cultivars suitable for production

Native fruit crops, such as black currant, chokecherry, highbush cranberry, and pincherry have substantial potential to contribute to the diversification of Saskatchewan's agricultural economy. Native and traditional fruit cultivar evaluation trials were established previously under the Canada-Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED).

All native fruit crops tested at CSIDC were planted in the fall of 1994 and the spring of 1995. During the project, survival and growth data were collected from black currant, chokecherry, highbush cranberry, and pincherry cultivar trials. Fruit yield and size data were collected from the black currant and chokecherry trials.

Development of Irrigation Guidelines to Enhance Saskatoon and Chokecherry Production and Fruit Quality

R. St-Pierre[1], L. Tollefson[2], B. Schroeder[3]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Scientifically established guidelines for irrigation of chokecherry and saskatoon are currently not available. Chokecherry and saskatoon irrigation trials were established previously at SIDC (Outlook) and PFRA (Indian Head) under the Canada-Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED). Continuation of these trials under AFIF funding will help address the needs for improved management guidelines for these crops. A five year report of the project is in the process of data analysis and report preparation.

Progress: *Ongoing*

Location: *CSIDC, Outlook*
PFRA, Indian Head
Yorkton

Objective:
- To determine how the timing and quantity of irrigation affect growth, yield and fruit quality in saskatoons and chokecherries
- To define guidelines for irrigation of these crops.

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Herb Agronomy

J. Wahab[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year three of five*

Location: *CSIDC, Outlook*

Objective:
- To evaluate the adaptability of promising herbs to Saskatchewan growing conditions,
- To develop labour saving management practices for mechanized commercial production,
- To identify appropriate production and harvest methods to increase yield and improve quality, and
- To compare the effects of dryland and irrigated production on yield and quality.

Natural products are becoming increasingly popular for use as food flavourings, in cosmetics, and as health supplements in Europe and North America. Presently, the herb and spice industry is expanding very rapidly in Canada including Saskatchewan. To address the needs of this developing industry, the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) has expanded the herb research and development program with the objective of developing cost effective and labour saving production practices for commercial scale production of important herbs. This project is being conducted with financial support from the Canada-Saskatchewan Agri-Food Innovation Fund and with market directions from the Saskatchewan Herb and Spice Association. The herb species included in the agronomic studies include *Echinacea angustifolia*, feverfew, German chamomile, milk thistle, stinging nettle, and St John's wort. Many other aromatic, culinary, and medicinal herbs are also being evaluated in observational plots.

Studies were conducted at the field plots of CSIDC, Outlook, Saskatchewan. Many herb species are difficult to direct seed due to their extremely small seed size and due to seed dormancy. Most agronomy trials were conducted using transplants. Field transplanting was done using a Water-wheel planter. A plant spacing of 60 cm (between-row) and 30 cm (within-row) (24 x 12 in) was utilized for all tests except for the plant density studies. For the plant population studies, plant populations were adjusted by varying the within-row spacing while maintaining the between-row spacing at 60 cm (24 in). The direct seeded tests were established using a 'Fabro' plot seeder. For the irrigation studies supplemental irrigation was applied to maintain the soil moisture status at approximately 50% Field Capacity. Irrigation was applied using over-head sprinklers. During the 1999 growing season only 75 mm (3 in) of supplemental irrigation was applied as 280 mm (11 in) of rain was received (compared to the 60-year average of 237mm (9.3 in)) from April through September. Samples from various tests have been supplied to the Department of Plant Sciences, University of Saskatchewan, for quality evaluation.

[1]*CSIDC, Outlook*

Echinacea angustifolia

Seeding rate and row spacing effects on yield and quality for direct seeded crop grown under dryland and irrigation.

Treatments:	
Seeding rate:	60, 90, 120, 150, 180 seeds/m^2 (8, 12, 16, 20, 24 seed/ft^2)
Row spacing:	40, 60 cm (16, 24 in)
Growing conditions:	Dryland and irrigation

Inherent seed dormancy, and the requirement of light for germination, renders *Echinacea* a difficult crop for direct seeding. *Echinacea* is generally produced using transplants. Raising *Echinacea* from transplants requires high capital and labour inputs. This study examined the feasibility of direct seeding *Echinacea angustifolia* with the objective of reducing transplanting costs.

Overall yield under dryland was higher compared to irrigation (Table 1). This is likely due to the better soil conditions where the dryland plot was located, and due to minimal moisture stress during the 1999 growing season. The plant stand was approximately 14% of the original seeding rates both under irrigation and dryland. The relatively high co-efficients of variation for root yields could be due to the highly variable root growth of individual plants in a plot.

Under dryland, the lowest seeding rate of 60 seeds/m^2 (8 seeds/ft^2) produced the lowest dry root yield (876 kg/ha; 780 lb/ac) and increasing seeding rate produced higher root yields (Table 1). The highest yield (2089 kg/ha; 1880 lb/ac) was recorded for the 180 seeds/m^2 (24 seeds/ft^2) seeding rate.

In the irrigation test, seeding rate had no effect on dry root yield and ranged from 1013 kg/ha (902 lb/ac) for 90 seeds/m^2 (12 seeds/ft^2) to 1263 kg/ha (1124 lb/ac) for 180 seeds/m^2 (24 seeds/ft^2) (Table 1).

Row spacing (40, 60 cm; 12, 24 in) had no effect on dry root yield under both dryland and irrigated production (Table 1).

Fertilizer response studies for direct seeded Echinacea angustifolia.

Treatments:	
Nitrogen rate:	50, 100 kg N/ha (45, 90 lb N/ac)
Nitrogen applied:	Spring only, spring & fall (½ & ½)
Phosphorus rate:	50, 100 kg P_2O_5/ha (45, 90 lb P_2O_5/ac)

Presently, *Echinacea angustifolia* is grown under small scale organic and non-organic conditions. Effective fertilizer management is essential to increase yields and improve quality. Information on fertility management for direct-seeded *Echinacea angustifolia* is not available for Saskatchewan and the prairies. This study examined the effects of nitrogen and phosphorus application on root yield for direct seeded *Echinacea angustifolia* under irrigated production.

Plant stand count indicated that the stand establishment was 9.4% of the original seeding rate.

Application of 50 kg N/ha (45 lb N/ac) produced 1137 kg/ha (1012 lb/ac) of dry root (Table 2). Adding 100 kg/ha (90 lb/ac) nitrogen produced 17% higher root yield than 50 kg N/ha (45 lb N/ac) (Table 2).

Applying nitrogen once only (in the spring) or as two equal split applications (in the spring and fall) had no difference on root yield (Table 2).

Applying 100 kg P_2O_5/ha produced 1473 kg/ha dry root. This was 48% higher than 50 kg P_2O_5/ha of applied phosphorus (Table 2).

Table 1. Seeding rate and row spacing effects on plant stand and dry root yield for direct seeded *Echinacea angustifolia* grown under dryland and irrigation

Seeding rate (seeds/m²)	Dry root yield			
	Dryland		Irrigation	
	kg/ha	lb/ac	kg/ha	lb/ac
60	876	788	1147	1032
90	1090	981	1013	912
120	1448	1303	1459	1313
150	1352	1217	1103	993
180	2089	1880	1263	1137
Row spacing (cm)				
40	1272	1145	1218	1096
60	1457	1311	1177	1059
Analyses of Variance				
Seeding rate (R)	**(580)		NS	
Row Spacing (S)	NS[1]		NS	
R x S	NS		NS	
CV (%)	41.3		29.1	

[1]not significant
**significant at P<0.01 level of probability
Value within parenthesis is LSD (5%) estimate for the corresponding treatment.

Table 2. Nitrogen and phosphorus effects on dry root yield of direct-seeded *Echinacea angustifolia* harvested three years after seeding.

Treatment		Dry root yield	
		kg/ha	lb/ac
Nitrogen rate	50 kg N/ha	1137	1023
	100 kg N/ha	1331	1198
Time of application	Spring	1228	1105
	Spring & fall	1239	1115
Phosphorus	50 kg P_2O_5/ha	995	896
	100 kg P_2O_5/ha	1473	1326
ANOVA LSD (0.05)			
Nitrogen rate (N)		*(230)	
Nitrogen application (A)		NS[1]	
Phosphorus rate (P)		***(230)	
N x A		NS	
N x P		NS	
A x P		NS	
N x A x P		NS	
CV (%)		23.9	

[1]not significant
*significant at P<0.05; *** significant at P<0.001

Comparison of planting material types for transplanted *Echinacea angustifolia*

Raising *Echinacea* transplants in the spring requires heated greenhouse facilities that requires substantial additional cost. Alternatively, transplants can be raised during the fall, overwintered in a straw covered pit, and planted in the following spring. The second method does not require any specialized growth structures, thereby reducing cost. This study was designed to compare different methods of producing and over-wintering *Echinacea angustifolia* transplants on root yield.

Treatments:

Transplant production:

Production season	Over-wintering	Container type
1997 fall	Heated greenhouse	50-cell plug tray
1997 fall	Straw covered pit	50-cell plug tray
1998 spring		50-cell plug tray
1998 spring		Bare root

Plant spacing: 15, 30 cm, (6, 12 in)

Transplants grown in the fall and over-wintered in the straw-covered pit produced the highest dry root yield compared to the other treatments (Table 3). This yield advantage was 36% higher than the transplants grown in plug trays during 1998, 41% higher than the transplants produced in 1997 and grown in plug trays through the winter of 1997 in the greenhouse, and 99% higher than the bare-root plants produced in the spring of 1998.

The 60 x 30 cm (12 x 6 in) plant spacing yielded 858 kg/ha (764 lb/ac) dry root. Doubling the plant population produced 34% higher yield than the lower plant population (Table 3).

Table 3. Effect of planting material and plant spacing on dry root yield for transplanted *Echinacea angustifolia* harvested two years after planting under dryland production

Treatment	Dry root yield	
	kg/ha	lb/ac
Transplant type		
Raised during fall 1997/ grown in greenhouse over winter	944	850
Raised during fall 1997/ over-wintered in a straw covered pit	1330	1197
Transplants raised in 1998: plug trays	1075	968
Transplants raised in 1998: bare root	670	603
Plant spacing		
15 cm (6 in)	1151	1036
30 cm (12 in)	858	772
Analysis of Variance		
Planting material (P)	***(236)	
Spacing (S)	***(167)	
P x S	NS[1]	
CV (%)	41.2	

[1]not significant
*** significant at P<0.001 level of probability
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Interactive effects of nitrogen, phosphorus and harvest age on root yield for transplanted *Echinacea angustifolia.*

Treatments:

Nitrogen rate:	50, 100 kg N/ha, (45, 90 lb N/ac)
Nitrogen applied:	Spring, Spring & fall (½ & ½).
Phosphorus rate:	50, 100 kg P_2O_5/ha, (45, 90 lb P_2O_5/ac)

Echinacea angustifolia roots are generally harvested three to four years after planting. Recent studies show that younger roots have a higher concentration of marker compounds than older roots.

However, the root yield will be lower when harvested at an early stage. This study examined the influence of fertilizers on root yield and active ingredient levels for *Echinacea angustifolia* when harvested at different crop ages.

Harvesting *Echinacea angustifolia* during the third year produced on average 49% higher dry root yield than harvesting the crop in the second year (Table 4).

Nitrogen rate, method of nitrogen application, or phosphorus rates did not affect dry root yield during the two harvest stages (Table 4).

Table 4. Nitrogen and phosphorus effects on dry root yield of direct-seeded *Echinacea angustifolia* harvested two and three years after seeding.

Treatment		Dry root yield			
		Year 2		Year 3	
		kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen rate	50 kg N/ha	723	651	1111	1000
	100 kg N/ha	725	653	1031	928
Time of application	Spring	659	593	1135	1022
	Spring & fall	789	710	1007	906
Phosphorus	50 kg P_2O_5/ha	693	624	1148	1033
	100 kg P_2O_5/ha	755	680	993	894
No fertilizer check		831	748	1280	1152
Analyses of Variance					
Nitrogen rate (N)		NS[1]		NS	
Nitrogen application (A)		NS		NS	
Phosphorus rate (P)		NS		NS	
N x A		NS		NS	
N x P		NS		NS	
A x P		NS		NS	
N x A x P		NS		NS	
CV (%)		42.4		42.0	

[1]not significant

Spacing and fertilizer effects for transplanted *Echinacea angustifolia.*

Under commercial scale production, appropriate agronomic practices should be adopted to maximize yields. This includes suitable plant populations and proper fertility management practices. It is likely that the response to fertility levels and plant populations can vary

Treatments:

Plant spacing:	15, 30 cm, (6, 12 in) (within-row).
Nitrogen rate:	0, 75, 150 kg N/ha, (0, 67, 134 lb N/ac)
Phosphorus rate:	0, 60 kg P_2O_5/ha, (0, 54 lb P_2O_5/ac)

between dryland and irrigated production. This study examined the interactive effects of nitrogen, phosphorus and plant population for transplanted *Echinacea angustifolia* grown under dryland and irrigated conditions.

The overall dry root yield under dryland production was 1992 kg/ha (1773 lb/ac) compared to 1886 kg/ha (1629 lb/ac) for irrigated production (Table 5).

Wider 60 x 30 cm (12 x 6 in) plant spacing, i.e. 55,500 plants/ha (22,500 plants/ac), produced 1196 kg/ha (1064 lb/ac) of dry root under dryland and 1320 kg/ha (1125 lb/ac) under irrigation (Table 5). Doubling the plant population by reducing the within-row spacing to 15 cm (6 in) produced 133% higher yield under dryland and 86% higher yield under irrigation.

Application of fertilizer nitrogen or phosphorus had no effect on root yields both under dryland and irrigated production conditions.

Table 5. Plant spacing, nitrogen and phosphorus effects on dry root yield for transplanted *Echinacea angustifolia* grown under dryland and irrigation: Year 3.

Treatment		Dry root yield			
		Dryland		Irrigation	
		kg/ha	lb/ac	kg/ha	lb/ac
Spacing	15 cm	2787	2508	2451	2206
	30 cm	1196	1076	1320	1188
Nitrogen	0 kg N/ha	2136	1922	1822	1640
	75 kg N/ha	1997	1797	1946	1751
	150 kg N/ha	1842	1658	1889	1700
Phosphorus	0 kg P_2O_5/ha	2020	1818	1906	1715
	60 kg P_2O_5/ha	1964	1768	1865	1679
Analyses of Variance					
Spacing (S)		***(331)		***(309)	
Nitrogen (N)		NS[1]		NS	
Phosphorus (P)		NS		NS	
S x N		NS		NS	
S x P		NS		NS	
N x P		NS		NS	
S x N x P		NS		NS	
CV (%)		28.2		27.8	

[1]not significant
*** significant at P<0.001 level of probability
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Feverfew

Spacing and fertilizer effects for transplanted feverfew.

Under commercial scale production, suitable agronomic practices should be adopted to maximize yields. This includes suitable plant populations and proper fertility management practices. It is likely that the response to fertility levels and plant populations can vary between dryland and irrigated production. This study examined the interactive effects of nitrogen, phosphorus and plant population for transplanted feverfew grown under dryland and irrigated conditions.

Treatments:

Plant spacing:	15, 30 cm, (6, 12 in) within-row
Nitrogen rate:	0, 75, 150 kg N/ha, (0, 67, 135lb N/ac)
Phosphorus rate:	0, 60 kg P_2O_5/ha, (0, 54 lb P_2O_5/ac)

Feverfew grown on dryland produced on average 18% higher fresh yield and 20% higher dry herbage yield relative to irrigated production (Table 6).

Table 6. Plant spacing and fertility effects on herbage yield for Feverfew grown under dryland and irrigation.

Treatment		Dryland yield				Irrigated yield			
		Fresh		Dry		Fresh		Dry	
		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Spacing	15 cm	20.7	18.6	5.0	4.5	18.3	16.5	4.4	4.0
	30 cm	19.2	17.3	4.7	4.2	15.4	13.9	3.8	3.4
Nitrogen	0 kg N/ha	18.7	16.8	4.7	4.2	16.8	15.1	4.1	3.7
	75 kg N/ha	20.7	18.6	4.9	4.4	16.8	15.1	4.1	3.7
	150 kg N/ha	20.3	18.3	5.0	4.5	17.0	15.3	4.2	3.8
Phosphorus	0 kg P_2O_5/ha	19.1	17.2	1.8	1.6	17.0	15.3	4.2	3.8
	60 kg P_2O_5/ha	20.7	18.6	4.9	4.4	16.7	15.0	4.0	3.6
Analyses of Variance									
Spacing (S)		NS[1]		NS		NS		NS	
Nitrogen (N)		NS		NS		NS		NS	
Phosphorus (P)		NS		NS		NS		NS	
S x N		NS		NS		NS		NS	
S x P		NS		NS		NS		NS	
N x P		NS		NS		NS		NS	
S x N x P		NS		NS		NS		NS	
CV (%)		14.6		12.7		13.9		14.9	

[1]not significant

Plant spacing, nitrogen, or phosphorus application had no effect on fresh and dry herbage yield under both dryland and irrigated production (Table 6).

Effects of plant population and cutting height on productivity and quality of transplanted feverfew.

Treatments:

Plant spacing:	15, 30 cm, (6, 12 in) within-row
Harvest stage:	Pre-flower, 10% flower, 100% flower

Different herb buyers tend to prefer feverfew harvested at different growth stages such as prior to flowering, during early flowering, or at full bloom. This study examines the interactive effects plant spacing and harvest stage on herbage yield and quality for transplanted feverfew grown under dryland and irrigated conditions.

Feverfew grown in dryland produced on average 15% higher fresh yield and similar dry herbage yield compared to irrigated production (Table 7).

Harvesting feverfew at the pre-flowering stage and at 10% flower produced similar yield of fresh and dry herbage both under dryland and irrigated production (Table 7). Under dryland, delaying harvest until 100% flower produced significantly higher herbage yields than the two early harvest stages.

Table 7. Plant spacing and harvest stage effects on herbage yield for Feverfew grown under dryland and irrigation.

Treatment		Dryland yield				Irrigated yield			
		Fresh		Dry		Fresh		Dry	
		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Spacing	15 cm	17.3	15.6	4.7	4.2	19.2	17.3	4.5	4.1
	30 cm	13.7	12.3	3.9	3.5	16.2	14.6	4.0	3.6
Harvest stage	Pre-flower	13.8	12.4	4.0	3.6	18.1	16.3	3.8	3.4
	10% flower	13.2	11.9	3.6	3.2	18.1	16.3	4.5	4.1
	100% flower	19.5	17.6	5.3	4.8	17.0	15.3	4.5	4.1
Analyses of Variance									
Spacing (S)		***(3.3)		**(0.5)		***(2.8)		NS	
Nitrogen (N)		***(3.8)		***(0.6)		NS		NS	
Phosphorus (P)		NS[1]		NS		NS		NS	
CV (%)		14.1		13.6		9.8		27.9	

[1]not significant
** significant at P<0.01; *** significant at P<0.001 levels of probability
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

German Chamomile

Spacing and fertilizer effects for transplanted crop.

Under commercial scale production, suitable agronomic practices including fertility management should be adopted to maximize yields. It is likely that the response to fertility levels can vary between dryland and irrigated production. This study examined the interactive effects of nitrogen, phosphorus, and potassium for transplanted German chamomile grown under dryland and irrigated conditions.

Treatments:

Nitrogen rate:	0, 100 kg N/ha, (0, 90 lb/ac)
Phosphorus rate:	0, 60 kg P_2O_5/ha, (0, 54 lb P_2O_5/ac)
Potassium:	0, 50 kg K_2O/ha, (0, 45 lb K_2O/ac)

German chamomile grown under dryland during the summer of 1999 produced over three-fold yield increase than irrigated production. The high yields for the dryland situation can be due to favourable moisture and soil conditions in the dryland location compared to the irrigated site.

Under dryland, application of 100 kg/ha (90 lb N/ac) nitrogen produced significantly higher shoot and total dry herbage yield, while nitrogen had no effect on flower yield (Table 8). Under irrigation, nitrogen application had no effect on flower, stem, or total dry herbage yield.

Phosphorus tended to lower flower, stem and total yields compared to the check treatment (Table 8). These differences reached significant levels for stem and total weight under dryland, and for flower weight under irrigation.

Potassium had no effect on plant component yields under dryland (Table 8). Significant phosphorus x potassium interactions were observed for the various plant parts under irrigation (Table 8). It appears that under low potassium (check) levels, adding phosphorus tended to reduce yields of all plant parts (Table 9). By contrast, under high potassium application, adding phosphorus tended to increase yields.

Table 8. Fertility effects on plant part dry herbage yield for German chamomile grown under dryland and irrigation.

		Dryland yield						Irrigated yield					
		Flower		Stem		Total		Flower		Stem		Total	
Treatment		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen	0 kg N/ha	854	769	2274	2047	3128	2815	223	201	719	647	942	848
	100 kg N/ha	909	818	2724	2452	3633	3270	248	223	607	546	855	770
Phosphorus	0 kg P_2O_5/ha	917	825	2744	2470	3661	3295	257	231	680	612	937	843
	60 kg P_2O_5/ha	846	761	2255	2030	3101	2791	214	193	646	581	860	774
Potassium	0 kg K^2O/ha	946	851	2438	2194	3384	3046	252	227	658	592	910	819
	50 kg K^2O/ha	818	736	2561	2305	3379	3041	219	197	667	600	886	797
Analyses of Variance													
Nitrogen (N)		NS[1]		*(387)		*(472)		NS		NS		NS	
Phosphorus (P)		NS		*(387)		*(472)		*(44)		NS		NS	
Potassium (K)		NS		NS		NS		NS		NS		NS	
N x P		NS		NS		NS		NS		NS		NS	
N x K		NS		NS		NS		NS		NS		NS	
P x K		NS		NS		NS		*(62)		*(170)		*(211)	
N x P x K		NS		NS		NS		NS		NS		NS	
CV (%)		26.9		21.1		18.9		25.2		24.6		22.5	

[1]not significant
*significant at $P<0.05$; **significant at $P<0.01$ levels of probability
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Table 9. Interactive effects of phosphorus and potassium on dry herbage yield for German chamomile grown under irrigation

	Dry herbage yield											
	Phosphorus											
	Flower				Stem + leaf				Total			
	0 kg P_2O_5/ha		60 kg P_2O_5/ha		0 kg P_2O_5/ha		60 kg P_2O_5/ha		0 kg P_2O_5/ha		60 kg P_2O_5/ha	
Potassium	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
0 kg K_2O/ha	302	272	202	182	738	664	579	521	1040	936	781	703
50 kg K_2O/ha	212	191	226	203	622	560	713	642	834	751	939	845

Effects of plant population, harvest height, and harvest method on yield and quality for transplanted German chamomile.

Under commercial production, German chamomile flowers are harvested by machine. The crop is harvested at different stages as determined by market requirement. This study examined the effects of plant population, and the stage and method of harvest on yield and quality.

Treatments:

Within-row spacing:	15, 30 cm, (6, 12 in)
Harvest height:	Ground level, 10 cm (4 in) above ground.
Harvest method:	Manual, mechanical.

Table 10. Mean effects of plant spacing, harvest stage, and harvest method on dry herbage yield for transplanted German chamomile grown under dryland and irrigation.

Treatment		Dry herbage yield			
		Dryland		Irrigation	
		kg/ha	lb/ac	kg/ha	lb/ac
Spacing	15 cm	2165	1949	2096	1886
	30 cm	2091	1882	1460	1314
Harvest height	10 cm	1987	1788	1783	1605
	Ground level	2269	2042	1773	1596
Harvest method	Hand	1362	1226	1125	1013
	Mechanical	2894	2605	2431	2188
Analyses of Variance					
Spacing (S)		NS[1]		***(256)	
Harvest height (H)		**(169)		NS	
Harvest method (M)		***(169)		***(256)	
S x H		NS		NS	
S x M		NS		*(362)	
H x M		***(238)		NS	
S x H x M		NS		NS	
CV (%)		10.8		19.6	

[1]not significant
*significant at P<0.05; **P<0.01:***P<0.001 levels of probability
Values within parenthesis are LSD (5%) estimates for the corresponding treatments.

Under irrigation, increasing plant population by closer (15 cm; 6 in) planting produced 44% higher 44% dry herbage yield than the 30 cm (12 in) plant spacing (Table 10). Under dryland, higher plant population did not provide any added yield advantage.

Under dryland, harvesting German chamomile at ground level produced 14% higher yields compared to harvesting at 10 cm (4 in) above ground (Table 10). Under irrigation both harvest heights produced similar yields.

Mechanical harvest produced higher yields both under dryland and irrigation (Table 10). It is unclear why mechanical harvesting produced higher yields than manual harvest.

The interaction significance between harvest method and plant spacing under irrigation (Table 10) indicates that higher plant population produced 38% higher herbage yield when harvested manually and 46% higher yield when harvested by machine (Table 11). However, the quality aspects of the harvested material will determine the actual value of the harvested product.

Table 11. Interactive influence of plant spacing and harvest method on dry herbage yield for transplanted German chamomile grown under irrigation.

Plant spacing	Dry herbage yield			
	Hand harvest		Mechanical harvest	
	kg/ha	lb/ac	kg/ha	lb/ac
15 cm	1304	1174	2888	2599
30 cm	946	851	1974	1777

Milk Thistle

Seeding rate and row spacing effects on plant stand, seed yield and quality.

Treatments:

Seeding rate: 50, 100, 200 seed/m², (7, 14, 28 seeds/ft²)
Row spacing: 20, 40, 60 cm, (8, 16, 24 in)

Milk thistle is a late maturing species with indeterminate growth and flowering habit. Under short Saskatchewan growing conditions, the later formed flowers may not mature. Cool environmental conditions and excess moisture can further delay flowering and maturity. This study examined the effects of seeding rate and row spacing on yield and quality of milk thistle grown under dryland.

Table 12. Seeding rate and row spacing effects on seed yield for milk thistle grown under dryland.

Treatment		Dry root yield	
		kg/ha	lb/ac
Seeding rate	50 seeds/m²	345.1	310.6
	100 seeds/m²	335.6	302.0
	200 seeds/m²	276.9	249.2
Row spacing	20 cm	316.3	284.7
	40 cm	386.4	347.8
	60 cm	254.9	229.4
Analysis of Variance			
Seeding rate (S)		NS[1]	
Row spacing (R)		*(145)	
S x R		NS	
CV (%)		23.9	

[1]not significant
*significant at P<0.05 level of probability
Value within parenthesis is LSD (5%) estimated for the corresponding treatment.

The overall yields in this test was relatively low. This was due to delayed maturity caused by excess moisture and relatively cool environmental temperatures during the growing season.

Seeding rate did not affect yields (Table 12). The 40 cm (16 in) row spacing produced higher seed yields than the 20 cm (8 in) or 60 cm (24 in) spacing (Table 12).

Stinging Nettle

Planting material comparison under dryland and irrigation.

Stinging nettle is a hardy perennial with extremely small seeds. Commercially, stinging nettle can be grown using transplants. This study is a continuation of the plots established in 1997 that was intended to examine the effects of plant material on herbage yield.

Treatments:

Production season	Over-wintering	Container type
1997 fall	Heated greenhouse	50-cell plug tray
1997 fall	Straw covered pit	50-cell plug tray
1998 spring		50-cell plug tray

Both the dryland and irrigated tests produced over 30 t/ha fresh herbage (Table 13). The yield responses were similar for all types of planting material.

Table 13. Effect of planting material on herbage yield for stinging nettle grown under dryland and irrigation.

Treatment	Dry root yield			
	Dryland		Irrigation	
	t/ha	t/ac	t/ha	t/ac
Transplant type				
Raised during fall 1997/ grown in greenhouse over winter	36.6	16.1	34.8	31.3
Raised during fall 1997/ over-wintered in a straw covered pit	33.8	14.9	36.1	32.5
Transplants raised in 1998: plug trays	33.4	30.1	37.0	33.3
Analyses of Variance				
Planting material (P)	NS[1]		NS	
CV (%)	16.8		13.4	

[1]not significant

Fertility studies for transplanted stinging nettle grown under dryland and irrigation

Stinging nettle root and shoot are used by the industry. It is likely that fertilizer application and production conditions (dryland or irrigation) can influence crop growth and root:shoot ratio. This study examines the effects of nitrogen and phosphorus application on root and shoot yield. The data on shoot yield is presented in this report.

Treatments:

Nitrogen rate:	50, 100 kg N/ha, (45, 90 lb N/ac)
Nitrogen applied:	Spring, spring + fall (½ + ½).
Phosphorus rate:	50, 100 kg P_2O_5/ha, (45, 90 lb P_2O_5/ac)

Stinging nettle grown under irrigation produced relatively higher shoot yield than dryland production (Table 14). Nitrogen rate, nitrogen timing or phosphorus had no effect on herbage production under dryland (Table 14). Under irrigation, the lower nitrogen rate increased herbage yield by 13% compared to the higher nitrogen level. Timing of nitrogen application and phosphorus had no effect on herbage yield. (Table 14).

Table 14. Nitrogen rate and timing and phosphorus effect on fresh herbage yield for transplanted Stinging nettle grown under dryland and irrigation.

Treatment		Fresh herbage yield			
		Dryland		Irrigation	
		t/ha	t/ac	t/ha	t/ac
Nitrogen rate	50 kg N/ha	31.9	14.0	41.4	18.2
	100 kg N/ha	32.7	14.4	36.8	16.2
Time of application	Spring	32.6	14.3	38.7	17.0
	Spring & fall	31.8	14.0	39.5	17.4
Phosphorus	50 kg P_2O_5/ha	33.7	14.8	38.1	16.8
	100 kg P_2O_5/ha	31.0	13.6	40.1	17.6
Nitrogen rate (N)		NS[1]		**	
Nitrogen application (A)		NS		NS	
Phosphorus rate (P)		NS		NS	
N x A		NS		NS	
N x P		NS		NS	
N x A x P		NS		NS	
CV (%)		7.7		11.0	

[1]not significant
**significant at P<0.05 level of probability

Plant spacing and cutting height effects for transplanted stinging nettle grown under dryland and irrigation

Treatments:

Plant spacing: 15, 30 cm, (6, 12 in).
Cutting height: Ground level, 10 cm, 15 cm (4, 6 in) above ground.

Stinging nettle leaf is one of the plant parts used for herbal remedies. Plant spacing and cutting height can affect herbage yield and quality. Moisture status during the growing season can also influence productivity and level of marker compounds. This study examines the effects of plant population and cutting height on the third-year stinging nettle crop grown under dryland and irrigation.

Irrigated stinging nettle produced 46% higher overall yield than the dryland crop (Table 15). Plant spacing or cutting height had no effect of fresh herbage yield both under dryland and irrigation (Table 15).

Table 15. Mean effects of plant spacing, harvest stage, and harvest method on dry herbage yield for transplanted German chamomile grown under dryland and irrigation.

Treatment		Fresh herbage yield			
		Dryland		Irrigation	
		t/ha	t/ac	t/ha	t/ac
Within-row spacing	15 cm	31.5	13.9	45.2	19.9
	30 cm	29.9	13.2	44.6	19.6
Cutting height	Ground level	28.7	12.6	42.1	18.5
	10cm	32.0	14.1	44.2	19.4
	15 cm	31.3	13.8	48.3	21.3
Analyses of Variance					
Spacing (S)		NS[1]		NS	
Cutting height (H)		NS		NS	
S x H		NS		NS	
CV (%)		14.9		17.4	

[1]not significant

St. John's Wort

The following studies were initiated in 1999 and harvest will commence in the 2000 season.

1. *Fertilizer response studies for St John's Wort grown under irrigated and dryland conditions.*

   The effect of nitrogen (0, 100 kg N/ha; 0, 90 lb N/ac) and phosphorous (0, 100 kg P_2O_5/ha; 0, 90 kg P_2O_5/ac) are being examined for Standard, Anthos, Elixer, and Topaz.

   Separate tests will be conducted for irrigation and for dryland.

2. *Effects of plant population and harvest methods on yield and quality characteristics for different biotypes.*

   The effect of nitrogen (0, 100 kg N/ha; 0, 90 lb N/ac) and phosphorous (0, 100 kg P_2O_5/ha; 0, 90 kg P_2O_5/ac) are being examined for Standard, Anthos, Elixer, and Topaz.

   Separate tests will be conducted for irrigation and for dryland.

Soils and Water Management Program

Soil and Water Management Program

Development and Extension of Precision Farming Techniques for Saskatchewan Producers

T. Hogg[1], M. Pederson[1], D. Pennock[2], F. Walley[2], M. Solohub[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Final Year*

Location: *R. Pederson, (SE 20-28-7-W3)*

Objective: *To develop an agronomic information package which can be used to tailor management practices to variable soil and moisture conditions within a given field.*

There is little basic agronomic information available for producers wanting to implement precision farming technology. The success of precision farming technology ultimately rests on our ability to develop effective management maps to guide producers in choosing appropriate input rates. Therefore, an agronomic information package must be developed which can be used to tailor management practices to variable soil and moisture conditions within a given field. The generation of seeding and fertilizer application equipment currently under development by major Saskatchewan equipment manufacturers will allow on-the-go adjustment of fertilizer and seeding rates.

In the spring of 1999, a plot was established at the selected site to determine the effect of variable nitrogen and phosphorus fertilizer and seeding rates on the grain yield, harvest index and grain quality of irrigated AC Barrie wheat across different landscape positions. Fertilizer treatments consisted of nitrogen and phosphorus applications based on soil test recommendations. The treatments were applied as a side band application utilizing urea (46-0-0) and monoammonium phosphate (12-51-0) as the nitrogen and phosphorus fertilizer sources. Each treatment strip was seeded over the complete range of landscape management units in a strip plot design and was replicated six times.

Irrigated AC Barrie wheat did showed significant differences among the landscape position, fertility and seeding rate treatments. Yield increased with nitrogen application up to 100 lb N/ac, phosphorus application up to 35 lbs P_2O_5/ac and seeding rate up to 1.5 bu/ac but showed no effect of landscape position (Table 1). Seed weight decreased as the nitrogen application rate increased beyond 100 lbs N/ac, increased with phosphorus application up to 35 lbs P_2O_5/ac and increased with seeding rate up to 1.5 bu/ac (Table 2). Protein content increased as the nitrogen rate increased within each landscape position and was generally higher for the upper and mid slope positions than the lower slope position for each nitrogen application rate (Table 3).

[1]CSIDC, Outlook

There were no significant effects of phosphorus rate or seeding rate on irrigated AC Barrie protein content. Test weight showed a general trend of decreasing from the upper slope position through the mid slope position to the lower slope position for each nitrogen application rate (Table 4). As well, test weight tended to decrease as the nitrogen application rate increased within each slope position. Test weight increased as the phosphorus applied was increased from 0 to 35 lbs P_2O_5/ac within each slope position. There was little change in test weight as the phosphorus applied was increased from 35 to 70 lbs P_2O_5/ac.

Table 1. Landscape position and fertilizer effects on yield of irrigated AC Barrie wheat.

N rate	P_2O_5 rate	Seeding rate		Yield Upper		Yield Mid		Yield Lower		Treatment Mean	
		kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac
0	0	100	1.5	3716	55.3	3642	54.2	3562	53.0	3636	54.1
100	0	100	1.5	4281	63.7	4341	64.6	4066	60.5	4227	62.9
0	35	100	1.5	3837	57.1	3810	56.7	3736	55.6	3797	56.5
50	35	100	1.5	4267	63.5	4368	65.0	4146	61.7	4260	63.4
100	35	100	1.5	4872	72.5	4738	70.5	4556	67.8	4724	70.3
150	35	100	1.5	4657	69.3	4617	68.7	4603	68.5	4630	68.9
200	35	100	1.5	4348	64.7	4281	63.7	4247	63.2	4287	63.8
100	35	67	1	4482	66.7	4462	66.4	4166	62.0	4375	65.1
100	35	134	2	4704	70.0	4476	66.6	4388	65.3	4523	67.3
100	70	100	1.5	4623	68.8	4281	63.7	4476	66.6	4462	66.4
Landscape Position Mean				4381	65.2	4301	64.0	4193	62.4		

ANOVA LSD (0.05)	kg/ha	bu/ac
Landscape Position (LP)	NS[1]	NS
Treatment (T)	242	3.6
LP x T	NS	NS
CV (%)	0.8	

[1]not significant

Table 2. Landscape position, fertilizer, and seeding rate effects on seed weight of irrigated AC Barrie wheat.

N rate	P_2O_5 rate	Seeding rate		Seed weight (mg) Upper	Seed weight (mg) Mid	Seed weight (mg) Lower	Treatment Mean
		kg/ha	bu/ac				
0	0	100	1.5	33.3	32.3	32.5	32.7
100	0	100	1.5	33.1	32.5	31.7	32.4
0	35	100	1.5	33.8	33.6	33.5	33.6
50	35	100	1.5	34.0	33.4	33.5	33.6
100	35	100	1.5	33.0	33.6	33.1	33.2
150	35	100	1.5	32.6	32.6	31.9	32.4
200	35	100	1.5	32.0	31.3	31.5	31.6
100	35	67	1.0	32.7	32.5	32.2	32.5
100	35	134	2.0	33.8	33.5	32.8	33.4
100	70	100	1.5	33.6	33.6	32.5	33.2
Landscape Position Mean				33.2	32.9	32.5	

ANOVA LSD (0.05)	
Landscape Position (LP)	NS[1]
Treatment (T)	0.5
LP x T	NS
CV (%)	2.3

[1]not significant

Seeding rate effects on test weight were similar to those observed for the phosphorus application rates in that test weight decreased from the upper slope position to the lower slope position and showed an increase as seeding rate increased from 1.0 to 1.5 bu/ac within each slope position with little change beyond 1.5 bu/ac.

These results are considered preliminary. Data from several site years is required before an agronomic information package can be developed to tailor management practices to variable soil and moisture conditions within a given field.

Table 3. Landscape position and fertilizer effects on protein content of irrigated AC Barrie wheat.							
N rate	P_2O_5 rate	Seeding rate		% Protein			Treatment Mean
		kg/ha	bu/ac	Upper	Mid	Lower	
0	0	100	1.5	12.3	11.9	12.2	12.1
100	0	100	1.5	13.5	13.2	13.1	13.2
0	35	100	1.5	12.3	12.3	12.4	12.3
50	35	100	1.5	12.7	12.4	12.5	12.5
100	35	100	1.5	13.3	13.5	13.2	13.3
150	35	100	1.5	13.9	13.8	13.5	13.7
200	35	100	1.5	14.2	14.1	13.6	14.0
100	35	67	1.0	13.2	13.3	13.3	13.3
100	35	134	2.0	13.5	13.3	13.3	13.3
100	70	100	1.5	13.4	13.2	13.3	13.3
Landscape Position Mean				13.2	13.1	13.0	
ANOVA LSD (0.05)							
Landscape Position (LP)					NS[1]		
Treatment (T)					0.2		
LP x T					0.3		
CV (%)					1.8		

[1]not significant

Table 4. Landscape position and fertilizer effects on test weight of irrigated AC Barrie wheat.											
N rate	P_2O_5 rate	Seeding rate		Test Weight						Treatment Mean	
				Upper		Mid		Lower			
		kg/ha	bu/ac	kg/hL	lb/bu	kg/hL	lb/bu	kg/hL	lb/bu	kg/hL	lb/bu
0	0	100	1.5	80.0	64.0	79.0	63.2	79.3	63.4	79.4	63.5
100	0	100	1.5	79.8	63.8	78.9	63.1	77.6	62.1	78.8	63.0
0	35	100	1.5	80.0	64.0	80.6	64.5	79.8	63.9	80.2	64.1
50	35	100	1.5	80.9	64.7	80.1	64.1	79.3	63.4	80.1	64.1
100	35	100	1.5	80.8	64.6	79.7	63.8	79.3	63.4	79.9	63.9
150	35	100	1.5	79.4	63.5	79.2	63.4	78.0	62.4	78.9	63.1
200	35	100	1.5	78.5	62.8	78.0	62.4	76.5	61.2	77.7	62.1
100	35	67	1	79.2	63.3	78.6	62.9	76.4	61.1	78.1	62.4
100	35	134	2	80.4	64.3	80.1	64.1	78.6	62.9	79.7	63.8
100	70	100	1.5	80.4	64.3	79.9	63.9	78.7	63.0	79.7	63.8
Landscape Position Mean				79.9	63.9	79.4	63.5	78.4	62.7		
ANOVA LSD (0.05)											
				kg/hL		lb/ac					
Landscape Position (LP)				0.8		0.6					
Treatment (T)				0.6		0.5					
LP x T				0.8		0.6					
CV (%)					0.8						

Effect of Water Quality on Efficacy of Selected Herbicide

T. Hogg[1], M. Pederson[1], A. Masich[2], L. Braul[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *One year*

Objective:
- To evaluate the effect of water quality on efficacy of selected grassy and broadleaf herbicides..
- To evaluate the effect of carrier water type and volume on herbicide

Trials were conducted at the Canada-Saskatchewan Irrigation Diversification Centre, Outlook, Saskatchewan to investigate the effect of water quality on herbicide efficacy. Two water quality/ herbicide screening trials were established to determine the effect of raw and treated (coagulated with aluminum sulfate) surface dugout water on the efficacy of grassy (Horizon, Puma Super, Poast Ultra, Liberty and Avenge 200C) and broadleaf (Refine Extra, Odyssey, 2,4-D Ester, 2,4-D Amine and Pardner) herbicides. Two additional trials were established to determine the effect of four water sources of differing quality (Raw dugout, Treated dugout, Hard and Local) and water mix volume (50 L/ha and 100 L/ha) on the efficacy of Roundup Transorb and Reglone Pro. All herbicides were applied at 25% of the recommended rate.

The results of the grassy herbicide screening trials indicate that for the grassy herbicides used, dugout water treated by coagulating with aluminum sulfate had a significant effect on herbicide efficacy when compared with raw dugout water (Table 1). The treated water significantly increased the efficacy of Puma Super, Poast Ultra and Liberty but had no effect on Horizon or Avenge 200C. There were differences among the grassy herbicides tested, with Horizon having the greatest efficacy and Avenge 200C having the least efficacy, similar to trends indicated by the visual ratings.

For the broadleaf herbicides tested, there was no significant effect of water quality on herbicide efficacy (Table 2). Visual damage indicated a difference in efficacy among the broadleaf herbicides tested with Refine Extra showing the greatest damage, however biomass production showed no significant differences among the herbicides tested.

For the water mix/water volume trials, Reglone Pro had greater efficacy when applied in a volume of 50 L/ha compared to 100 L/ha with no significant differences among the water types (Table 3). For the Roundup Transorb the 50 L/ha volume only improved efficacy for the Hard water source (Table 4). No other conclusions can be made for the water mix/water volume trials since no differences were observed, possibly a result of rainfall shortly after the herbicide/water treatments were applied.

[1]*CSIDC, Outlook*
[2]*Agriculture and Agri-Food Canada, PFRA*

Table1. Effect of water quality on the efficacy of selected grassy weed herbicides.

Herbicide	Visual Rating (0 - 100)[1]						Biomass (g/m^2)		
	14 Days After Application			28 Days After Application			21 Days After Application		
	Raw Water	Treated Water	Mean[2]	Raw Water	Treated Water	Mean[2]	Raw Water	Treated Water	Mean[2]
Horizon	60	53	56 b	73	75	74 d	209	204	206 a
Puma Super	35	60	48 b	15	35	25 c	466	325	395 bc
Poast Ultra	30	50	40 b	18	19	19 b	397	238	317 ab
Avenge 200C	0	0	0 a	0	0	0 a	510	514	512 c
Liberty	23	30	27 b	0	0	0 a	530	403	466 bc
Mean[3]	30 a	39 b		21 a	26 b		422 b	336 a	
Split-plot ANOVA	LSD (0.05)			LSD (0.05)			LSD (0.05)		
Herbicide (H)	0.3[4]			0.2[4]			152		
Water (W)	NS[5]			NS			39		
H x W	NS			NS			87		

Table 2. Effect of water quality on the efficacy of selected broadleaf weed herbicides.

Herbicide	Visual Rating (0 - 100)[1]						Biomass (g/m^2)		
	14 Days After Application			28 Days After Application			21 Days After Application		
	Raw Water	Treated Water	Mean[2]	Raw Water	Treated Water	Mean[2]	Raw Water	Treated Water	Mean[2]
2,4-D Amine	10	16	14 ab	8	8	8 ab	282	341	311 a
2,4-D Ester	39	38	39 bc	23	35	29 bc	239	285	275 a
Odyssey	36	54	45 c	13	30	22 abc	251	214	220 a
Pardner	3	5	4 a	0	0	0 a	345	370	345 a
Refine Extra	68	78	73 c	43	53	48 c	169	96	133 a
Mean[3]	31 a	38 b		17 a	25 b		257 a	261 a	
Split-plot ANOVA	LSD (0.05)			LSD (0.05)			LSD (0.05)		
Herbicide (H)	0.4[4]			0.4[4]			NS		
Water (W)	0.1			0.1			NS		
H x W	NS			0.1			NS		

On the above tables:
[1]Expert Committee on Weeds Visual Rating Scale (0=no control; 100=total control)
[2]Herbicide means in a column followed by the same letter are not significantly different at P=0.05
[3]Water means in a row followed by the same letter are not significantly different at P=0.05
[4]LSD based on transformed data [$\log_{10}$(value+10)]
[5]Not significant

Table 3. Effect of water quality and water volume on the efficacy of Reglone Pro.

Water Source	Visual Rating (0 - 100)[1] 14 Days After Application 50L/ha	100L/ha	Mean	28 Days After Application 50L/ha	100L/ha	Mean	Biomass (g/m^2) 21 Days After Application 50L/ha	100L/ha	Mean[2]
Raw Dugout	0	0	0	0	0	0	144	165	154 a
Treated Dugout	0	0	0	0	0	0	112	158	135 a
Hard	0	0	0	0	0	0	127	170	148 a
Local	0	0	0	0	0	0	162	167	164 a
Mean[3]	0	0		0	0		136 a	165 b	
Split-plot ANOVA							LSD (0.05)		
Volume (V)							27		
Water (W)							NS[4]		
V x W							NS		

Table 4. Effect of water quality and water volume on the efficacy of Roundup Transorb.

Water Source	Visual Rating (0 - 100)[1] 14 Days After Application 50L/ha	100L/ha	Mean[2]	28 Days After Application 50L/ha	100L/ha	Mean[2]	Biomass (g/m^2) 21 Days After Application 50L/ha	100L/ha	Mean[2]
Raw Dugout	15	3	9 a	0	0	0 a	143	211	177 a
Treated Dugout	13	10	12 a	0	0	0 a	158	139	148 a
Hard	30	3	17 a	10	0	5 a	132	220	176 a
Local	0	10	5 a	0	0	0 a	240	195	217 a
Mean[3]	15 a	7 a		3 a	0 a		168 a	191 a	
Split-plot ANOVA		LSD (0.05)			LSD (0.05)			LSD (0.05)	
Volume (V)		NS[4]			NS			NS	
Water (W)		NS			NS			NS	
V x W		0.3[5]			NS			74	

On the above tables:
[1]Expert Committee on Weeds Visual Rating Scale (0=no control; 100=total control)
[2]Herbicide means in a column followed by the same letter are not significantly different at P=0.05
[3]Water means in a row followed by the same letter are not significantly different at P=0.05
[4]Not significant
[5]LSD based on transformed data [$\log_{10}$(value+10)]

Agrochemicals in the Soil and Groundwater under Intensively Managed Irrigated Crop Production

J. Elliott[1], A. Cessna[1], P. Flegg[1], T. Hogg[2], J. Wahab[2], L. Tollefson[2], B. Vestre[2]

Funded by the National Soil and Water Conservation Program

***Progress**: Ongoing*

Objective:
- To quantify the effect of agrochemical use under intensive irrigated potato production on soil and groundwater
- To assist in the development of environmentally sustainable best management practices for potatoes.

Seed potato (*cv* Penta) was grown in 1998 (Field 4&5) and 1999 (Field 1) with four nitrogen-fertilizer treatments typically used in potato production. (see below).

Urea (46-0-0) was used for all applications except fertigation where urea-ammonium nitrate solution (28-0-0) was used. P and K were applied to meet crop requirements at the same rate on each plot. Pesticide applications included seed treatment and insecticide, herbicide and fungicide applications. They were the same for all treatments. In 1999 canola was grown on Field 4&5.

Soil samples were taken at 30 cm increments to 1.8 m from 6 locations in each plot prior to the pre-planting fertilizer application and after harvest. Water samples were taken from stainless steel piezometers centrally located in each plot every week from May to September (less frequently in the fall and winter). The samples were analyzed for nitrate (NO_3), ammonia, total phosphorus and ortho phosphorus and the pesticides applied to the potatoes. Potato yield and size grade were measured on samples from 6 locations in each plot.

There was no significant effect of fertilizer treatment on tuber yield or size grade in 1998 but in 1999 both total yield and yield of tubers >45 mm was lower on the "300" plot than the others. In both years the water table rose beneath the potato plots during the growing season (Figure1).

Nitrogen -Fertilizer treatments:

"300"	300 kgN/ha incorporated prior to seeding
"200"	200 kgN/ha incorporated prior to seeding
Split	100 kgN/ha incorporated prior to seeding and 100 kgN/ha applied at hilling
Fert	100 kgN/ha incorporated prior to seeding and the balance applied through fertigation according to petiole analysis

[1]*National Water Research Institute, Saskatoon*
[2]*CSIDC, Outlook*

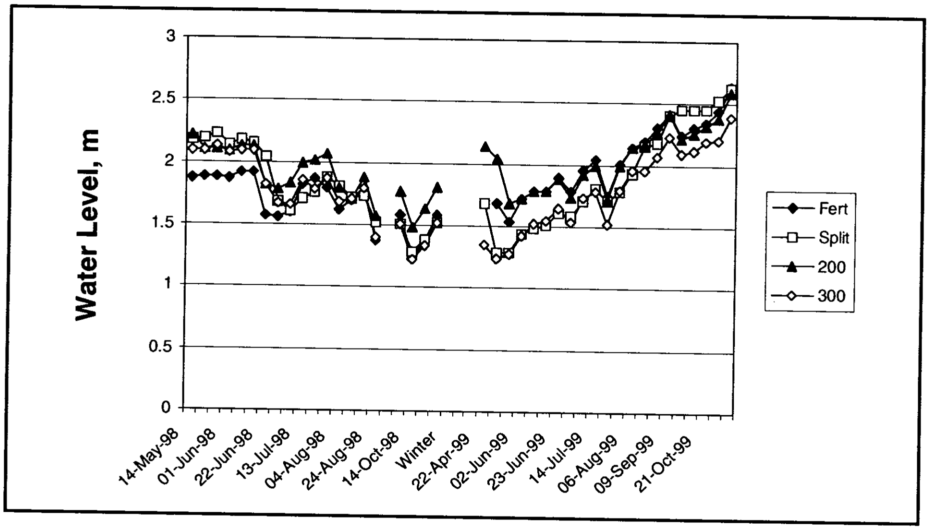

Figure 1. Water levels in the piezometers on Field 4&5 in 1998 and 1999.

Although the water table rose under potatoes the level dropped during the 1999 season when canola was grown. The water moving through the soil profile under the potato crop carried NO_3-N to the shallow groundwater causing NO_3-N concentrations to rise (Figure 2). In 1999 NO_3-N concentrations under the "300" plot continued to rise while the canola crop was grown but under the Split and "200" plots NO_3-N concentration decreased. Nitrate concentrations generally increased at all depths in the soil profile during potato production. The loss of NO_3-N from the soil profile while canola was grown in 1999 was comparable to that gained with potatoes in 1998.

None of the pesticides applied to the potatoes in 1998 were detected in the groundwater. Samples from 1999 have not yet been analysed for pesticides.

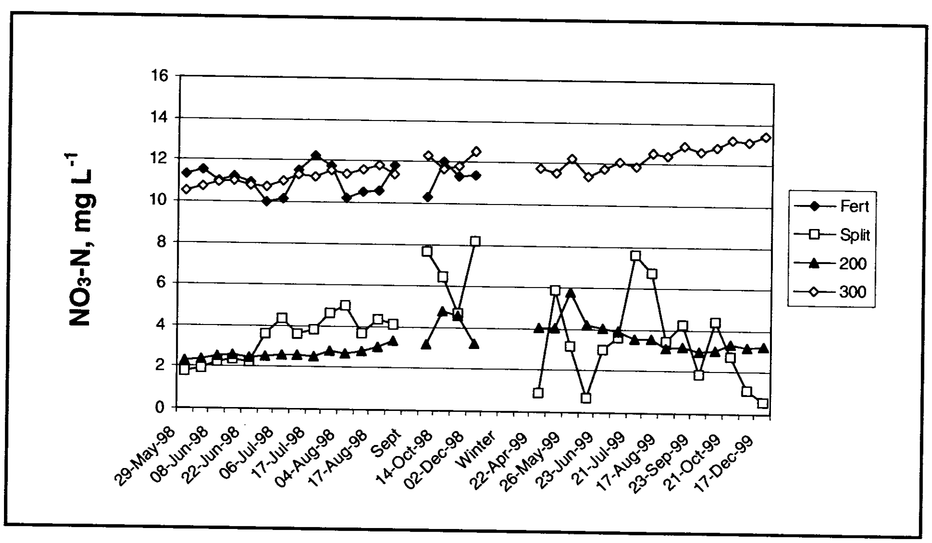

Figure 2. Nitrate-N concentrations in the piezometers on Field 4&5 in 1998 and 1999.

Market Analysis and Economics

Market Analysis and Economics

H. Clark[1]

Progress: *Ongoing*

Objective:
- To assist producers to diversify by identifying higher value market opportunities.
- To help direct the CSIDC applied research and demonstration program by evaluating the potential for irrigated crops.
- To assist the establishment of value-added processing by identifying markets.
- To assist rural development by evaluating crop diversification and processing opportunities.

The objectives of the market analysis and economics program are met in part by assembling and analysing information on the major irrigated crops and on a wide range of specialty crops. Price and expected returns of these crops are summarized and presented each spring. This information is available from SIDC, or may be found on the internet at http://www.agr.ca/pfra/sidcpub.

The market analyst prepares updates and reports which are circulated to internal and external clients on a regular basis.

Market analysis and economics projects completed over the past year include:

- An update of irrigated costs and returns information for the PFRA Prairie Agriculture Landscapes project.
- Provision of water and irrigation data for PFRA and CANCID projects.
- An update of price information for herbs and spices was provided for a herb and spice market development project sponsored by the Saskatchewan Herb and Spice Association.
- Assembly and analysis of producer and wholesale prices and market information on vegetable and potato crops.
- An analysis of vegetable cost and return analyses was performed in support of the horticulture program at CSIDC
- Crop market outlooks for cereals, oilseeds, pulse crops, and forage and forage seed crops are prepared and published in January of each year.

[1]*CSIDC, Outlook*

The Irrigated Crop Mix in Western Canada

H. Clark[1]

Irrigation provides the opportunity to grow an increased variety of crops, including several which are not well suited to dryland production on the prairies. Estimates of the percent of irrigated area are used to help target the research and demonstration effort, and to provide a baseline against which efforts at crop diversification and intensification can be measured.

The irrigated crop mix for Saskatchewan and Alberta is similar (Figures 1 and 2), with cereals, forages, and oilseeds predominant. The primary irrigated crop in Manitoba is potato, comprising 69% of all irrigated crop land (Figure 3).

An estimate of irrigated area by irrigation type is presented in Table 1. The majority of irrigation is done using sprinkler systems. Center pivot systems are the primary type of sprinkler equipment in use, although there remains a significant area irrigated by wheel line systems in Alberta (Table 2). The backflood irrigation in Saskatchewan is used primarily to irrigate forages.

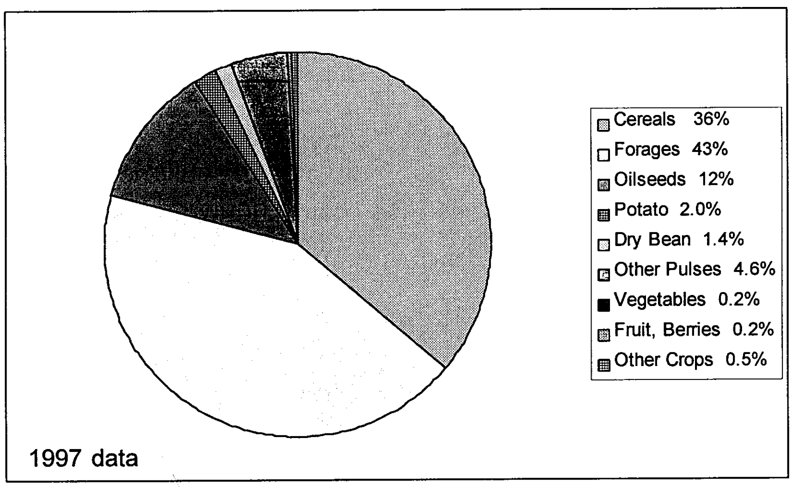

Figure 1. Saskatchewan irrigated area by crop.

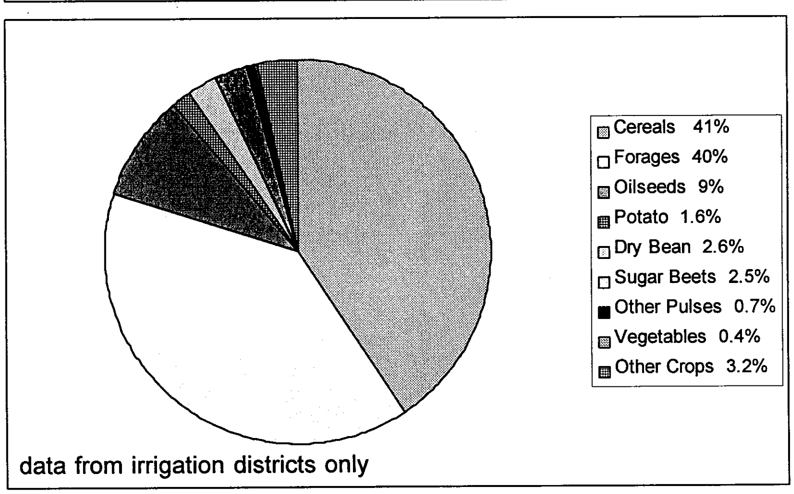

Figure 2. Alberta irrigated area by crop.

[1]*CSIDC, Outlook*

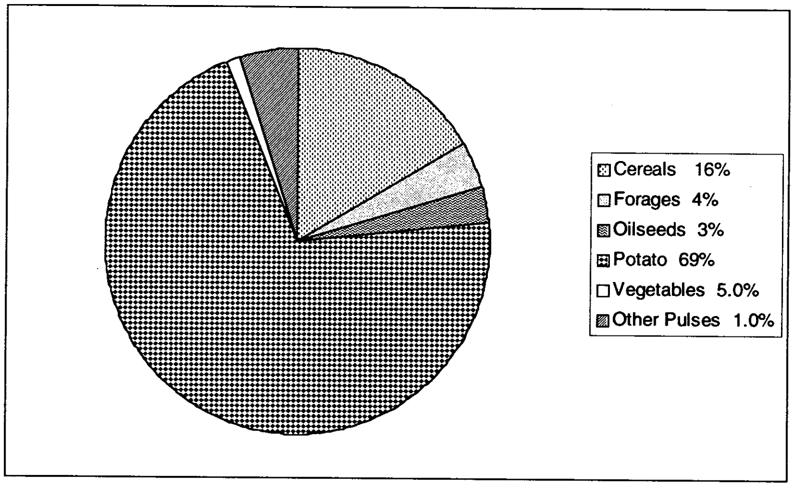

Figure 3. Manitoba irrigated area by crop.

Table 1. Irrigation system type by province as total area (ha) and as a % of total area.

Type of system	Alberta		Saskatchewan		Manitoba		Western Canada	
	ha	%	ha	%	ha	%	ha	%
Sprinkler	394,700	76	66,070	52	26,470	100	487,240	72
Surface/Flood	104,040	20	25,620	19	30	<1	129,690	19
Backflood	---	---	37,940	29	---		37,940	6
Trickle	290	<1	---	---	10	<1	300	<1
Other	18,120	4	720	<1	---		18,840	3
Total	517,160	100	130,350	100	26,520	100	674,020	100

Table 2. Breakdown of sprinkler irrigated area by sprinkler system by province.

Sprinkler system	Alberta		Saskatchewan		Manitoba		Western Canada	
	ha	%	ha	%	ha	%	ha	%
Center pivot	201,630	51	45,000	68	14,600	55	261,230	54
Wheel line	186,190	47	15,550	24	1,110	4	202,850	42
Volume gun	1,230	<1	---	---	8,900	34	10,140	2
Solid set	3,950	1	---	---	470	2	4,420	1
Linear move	1,700	<1	250	<1	1,390	5	3,350	<1
Other[1]	---	---	5,260	8	---	---	5,260	1
Total	394,700	100	66,070	100	26,470	100	487,240	100

[1]Includes systems for which data is not available

Cost of Production Estimates for Selected Vegetable Crops

H. Clark[1], B. Vestre[1], O. Green[1]

Cost of production and returns for pumpkin, carrot, cabbage, peppers, and cucumber were estimated using data from the commercial vegetable production demonstration at CSIDC.

The results of the analysis are summarized in Table 3 as a three year average of actual costs incurred on the 0.2 ha (0.5 ac) plots, and as a projected estimate of production on a full commercial scale assuming the use of appropriate equipment, storage, and production technologies. All values are expressed on an area basis. A full description of the estimated costs and returns is available on request.

Pumpkin and carrot hold the greatest potential for commercial production by these estimates (Table 3). Producers are cautioned that the pumpkin market is limited and highly seasonal. Pepper production on average appears promising, but yields are dependent on warm weather and therefore have been highly variable. Cucumber returns have been low due, primarily, to high harvest and post-harvest labour costs.

Table 3. Average and projected costs and returns for selected vegetable crops ($/ac).

	Pumpkin		Carrot		Cabbage		Pepper		Cucumber	
	Average[1]	Projected[2]	Average	Projected	Average	Projected	Average	Projected	Average	Projected
Gross return	14,150	12,000	7,630	10,000	7,150	9,000	10,170	12,000	10,100	10,000
Expenses:										
Variable	4,960	2,790	3,500	3,360	2,630	3,120	4,740	5,410	3,640	3,980
Labour	2,530	2,050	2,600	1,950	2,160	2,800	2,810	3,550	4,650	4,000
Fixed	450	520	1,170	1,040	990	1,130	820	850	460	520
Total Expense	7,940	5,350	7,270	6,350	5,770	7,050	8,370	9,800	8,750	8,500
Net return	6,200	6,650	360	3,650	1,380	1,950	1,800	2,200	1,350	1,500

[1]Average of actual costs for the commercial vegetable production demonstration, 1997 to 1999.
[2]Projection based on estimated costs and returns for commercial scale production.

[1]*CSIDC, Outlook*

Field Demonstration Program

Field Demonstration Program

The ***Irrigation Crop Diversification Corporation*** *(ICDC) is the provincial organization responsible for irrigation research, demonstration, and extension. It was formed under The Irrigation Act 1996.*

ICDC conducts field demonstrations in the Lake Diefenbaker area in order to field test ideas that come from research at CSIDC and other institutions. These field demonstrations are monitored weekly and data is collected. This data is entered into a database and is used to develop agronomic recommendations. This information will be used to direct and influence irrigated crop production in the province. Demonstration co-operators pay $2.00 per acre to have their field monitored. ICDC informs the co-operator of any problems developing in the crop. ICDC reimburses the co-operator for any extra cost involved in hosting the demonstration plot.

Crop Manager Demonstration

I. Bristow[1], D. Oram[2], L. Schoenau[2]

Progress: *Ongoing*

Objective: *To evaluate the response of micronutrient fertilizer on dry bean in order to increase crop yield.*

Micronutrient Foliar Feed on Dry Bean

This is a common practice among bean producers from other regions and has bean readily adopted in Saskatchewan because it is a relatively small cost in the production of dry beans. Research at CSIDC has not shown a significant response to micronutrient fertilizer. ICDC trials conducted on dry bean fields for three years have shown no yield response to added micronutrient fertilizer. Soil testing and tissue testing can be used to detect nutrient deficiency. An application of micronutrient fertilizer can correct the deficiency but may not result in a yield increase.

[1]*ICDC, Outlook*
[2]*Bloomfield Consulting, Central Butte, Saskatchewan*

Nitrogen Fertility for Dry Bean

Research at CSIDC suggested that beans yielded more at higher nitrogen rates than those currently being recommended. Beans are poor nitrogen fixers and have responded well to the high nitrogen rates in these demonstrations. Nitrogen rates of 60-80 lbs per acre total soil nitrogen in the top 12 inches produce the best yield on loam and clay loam soil. Sandy soils require 80-100 lbs per acre to maximize yield. High nitrogen levels in the soil can delay maturity and increase disease incidence depending on weather conditions.

Progress: *Ongoing*

Objective: *To demonstrate the effects of high nitrogen rates on dry bean*

Soil Ripping of Dry Beans

Progress: *Ongoing*

Objective: *To show the benefits of soil ripping in dry bean crops.*

Soil ripping is done with a row crop cultivator. Narrow shanks are added to the cultivator that rip the soil to a depth of 20 cm (8 in). ICDC trials in 1998-99 have shown an average yield increase of 10%. Soil ripping aerates the soil and improves water infiltration rate. Soil ripping improves dry bean root development on compacted loam and clay loam soils. Soil ripping reduces disease incidence by improving water infiltration and loosens the soil which makes the crop easier to undercut.

Cereal Fungicide Demonstration

The Disease Decision Guide produced at CSIDC was tested for its accuracy in predicting the need for fungicide application. The last three years have been very different for disease development. It was hot and dry in 1997, average in 1998, and cool with above average moisture in 1999.

Our data suggests that CPS wheat will respond economically to fungicide even during years of depressed prices and dry conditions. HRS wheat and durum were more closely examined in 1999.

Progress: *Ongoing*

Objective: *To show the benefits of using foliar applications of fungicide to control leaf diseases in cereal crops.*

Two of the six durum sites showed an economic benefit from fungicide in 1999. These two sites were on potato stubble, where a very dense crop canopy developed. Both were sprayed early when disease presence was low.

All of the grain samples this year were downgraded due to disease development late in the growing season. The cool, wet conditions throughout July and August promoted disease development. One application of fungicide did not adequately control the disease. The cereal fungicide demo has shown when and how to look for diseases in wheat as well as how to stage the crop to apply the chemical at the optimal time. The Disease Decision Guide was found to be accurate in predicting the need for fungicide application in 65% of the demonstrations.

Durum Variety Demonstration

Stip trials allow for accurate comparison of yield, grade, crop height, lodging tolerance, and disease resistance. This is a demonstration of those varieties best suited to irrigation.

Progress: *Ongoing*

Objective: *To field test durum wheat varieties of crops on a field scale before they become commercially available.*

Three new durum varieties were demonstrated. AC Avonlea, AC Morse, and AC Navigator. AC Morse was developed at the Agriculture Canada research station in Winnipeg. AC Navigator and AC Avonlea were developed at the Agriculture Canada research station in Swift Current. These varieties are aimed at North American and European markets that are demanding strong gluten durum. ICDC funds ongoing research into crop varieties for irrigation.

AC Avonlea, AC Navigator, and AC Morse have performed well in field trials. These new durum varieties have improved lodging resistance, higher yield, and better quality than older varieties such as Plenty and Sceptre which are commonly grown under irrigation.

Canola Fungicide Demonstration

The canola fungicide trial was new for 1999 and was sponsored by Alice Wilson of BASF. Ronilan was applied to canola for control of sclerotinia.

Progress: *Ongoing*

Objective: *To evaluate the efficacy of recently registered fungicides for the control of Sclerotinia in canola*

Untreated checks were compared to one application of Ronilan at 0.4 kg/acre and two applications of Ronilan at 0.2 kg/acre each. Disease presence, crop rotation, and weed control were factors that affected the potential yield increase from the Ronilan treatments. Two field were very weedy and had low disease pressure resulting in no significant yield difference. Another two fields had low disease pressure and showed no significant difference in yield. One field in the demonstration, however, had high disease pressure and showed a yield increase of eight bushels per acre. Cool, wet weather conditions are ideal for *Sclerotinia* development. Yield potential and canola prices are factors to consider when deciding if a fungicide application is needed.

Forage Manager Demonstration

L. Bohrson[1], K. Olfert[1]

Haywatch Saskatchewan

A majority of the irrigated acres in Saskatchewan are in forage production of which alfalfa is predominant. One very simple way of adding value to this product is to increase its quality in a way that directly affects the end consumer (dairy or beef cow). There are two steps in this process. First, the hay producer must have a way of estimating the quality in the field to decide the cutting date, and second, the way the producer assesses quality affects milk or beef production. Haywatch Saskatchewan is a program that has been designed to not only increase producer awareness of the quality factors that influence hay value, but also to demonstrate how to more precisely describe the stages of growth of an alfalfa plant. By being aware of the stage of growth and the quality associated with that stage, the irrigator will be better able to target the quality that buyers are asking for. This program also evaluates hay quality prediction equations and attempts to modify them for Saskatchewan conditions.

Progress: *Ongoing*

Objective:
- To increase producer awareness of the quality factors that influence their hay
- To describe the stages of growth of an alfalfa plant.

Relative Feed Value

The Relative Feed Value (RFV) is a term developed to more accurately describe the quality of alfalfa. It is based on the two fibre measurements: Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF). These are two laboratory methods of determining the amount of indigestible fibre. The ADF is a much more rigorous analysis and measures only lignin and cellulose content. The NDF is less severe and leaves the hemi-cellulose, cutins, silica, and tannins intact in addition to the cellulose and lignin. Therefore the % NDF will be greater than the % ADF.

To estimate Total Digestible Nutrients (TDN), the ADF is used because a portion of the NDF is digestible. Although this portion is digestible, it is not readily digestible. In order for the ruminant to be able to utilize it, it must spend a significant amount of time in the rumen, which affects feed intake. NDF is used to estimate a Dry Matter Intake (DMI). In an intensive livestock production system it might be more efficient to let some of the less digestible nutrients go through the rumen in order to increase feed intake of the easily digestible nutrients.

The Relative Feed Value uses both ADF and NDF as a basis for it's calculation. A forage described by a RFV number takes into account not only the digestibility of the forage, but also the intake. A RFV of 100 was set for an alfalfa stem that is blooming (Stage 6). Alfalfa at 100% bloom is coarse and not a high quality forage.

[1]*ICDC, Swift Current*

Dairy quality hay generally has an RFV of 150 or greater.

< Beef Quality >< Dairy Quality >

Intensive Cow / Calf Production — High Milk Production

...100..........110..........120..........130..........140..........150..........160..........170..........180...

Haywatch Saskatchewan Maturity Results

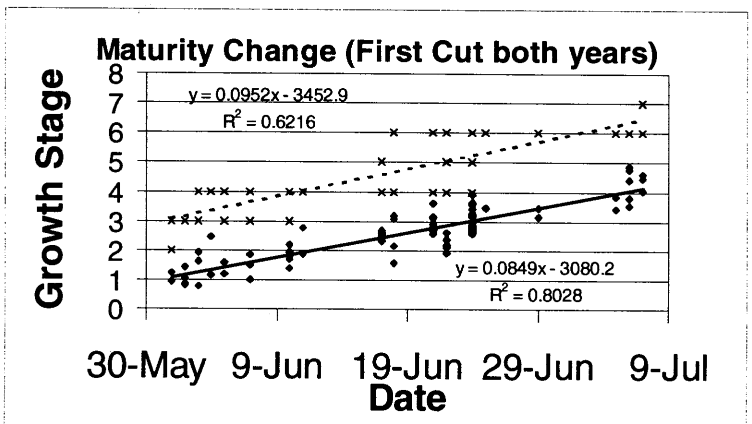

Figure 1. This graph depicts the rate of alfalfa maturation during first cut. It is an average over two years. The solid line is the regression line for the Mean Stage Count (MSC) and the dotted line is for the most mature stem. With a slope of 0.08 stages per day, 12 days are required to mature through one stage (MSC).

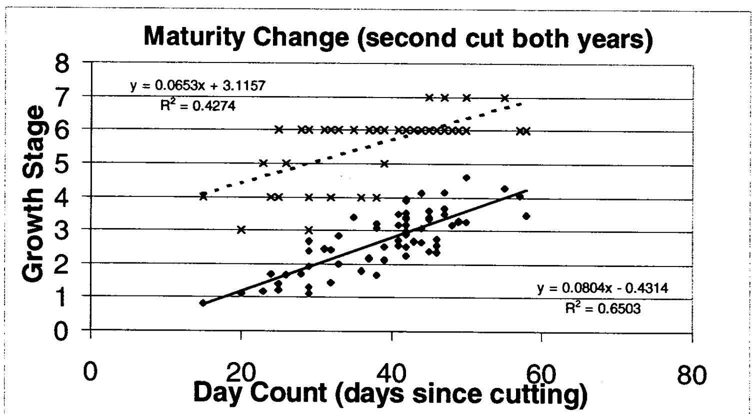

Figure 2. This graph depicte the rate of alfalfa maturation for the second cut averaged over two years. The dotted line represents the most mature stem and the solid line represents the MSC. The slope of the linear regression line for the MSC is similar to first cut, which suggests that alfalfa grows at the same rate in both the first and second cuts.

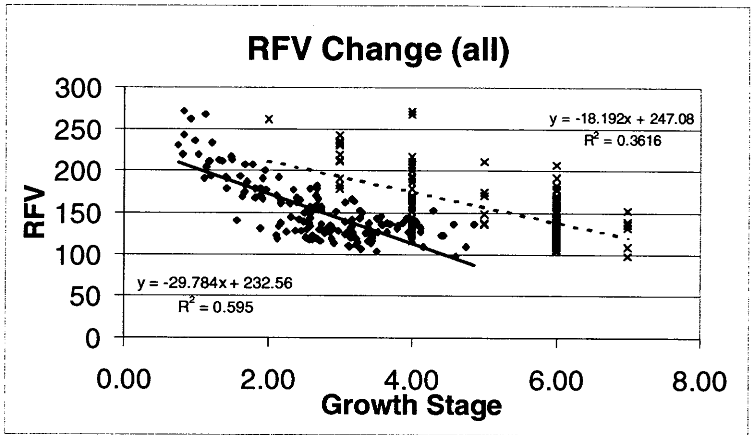

Figure 3. This graph depicts the change in RFV value as the alfalfa matures. The solid line represents the MSC and the dotted line represents the most mature stem. The RFV decreased as the alfalfa matured, although the amount of fibre tended to level off in the later growth stages. If the growth rate of 12 days per stage is applied, the **RFV will decrease about 2.5 RFV points per day.**

RFV Harvest Losses

There are losses in RFV due to the harvesting process. The losses are mainly due to continued respiration, and especially to nutrient leaching if the hay is rained on. On average 17 RFV points were lost in 1999 going from standing green plants to stacked bales, although the reduction varied greatly. In 1998 the average RFV loss was 16 points. Hay that got rained on lost up to 60 RFV points. Hay harvested under ideal conditions maintained its RFV value. Manitoba Agriculture suggests a loss of about 15 RFV points due to harvesting. The key to producing high quality hay is to start with the highest potential possible, so that once haying losses are accounted for, the desired quality is achieved.

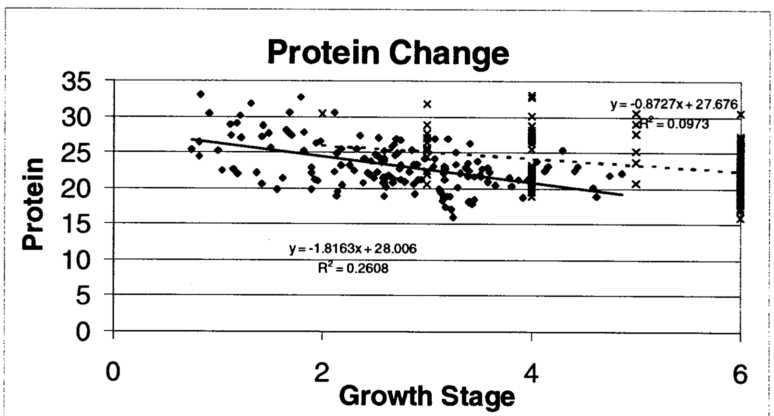

Figure 4. This graph depicts protein contents changes as the alfalfa matures. The solid line is the regression line for the MSC, and the dotted line is the regression for the most mature stem. An increase in fibre as the plant matures dilutes the protein. In 1999 there was a steady decrease in protein content with maturation. The R^2 value (0.26), does not allow meaningful estimates of the rate of decrease to be established.

Prediction Equations of Alfalfa Quality (PEAQ)

Researchers in the dairy states have developed a number of equations to predict the fibre levels in alfalfa using the height of the tallest plant and the maturity of the most mature plant. Hintz and Albrecht (1991) developed the original equations. Owens, et.al. (1995) developed a revised set of equations: One for first cut, and one for the second and third cuts. Sulc, et.al. (1997) used a much larger dataset (the 'Ohio' dataset) from across a number of states to derive the equations. This project evaluated each of the Sulc equations to determine those which most accurately predicted hay quality for Saskatchewan conditions. Predictions were also developed from our own data as follows:

$$NDF = 20.9 + (0.134 \times height) + (1.79 \times maturity)$$

$$ADF = 15.5 + (0.117 \times height) + (1.62 \times maturity)$$

$$RFV = 0.775 \times [88.9 - (0.779 \times ADF)] \times (120 / NDF)$$

1999 ICDC Demonstration Sponsors and Objective Partners

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Direct Seeding Demonstration

K. Sapsford[1], B. Vestre[2]

Funded by the Saskatchewan Soil Conservation Association

***Progress:** Ongoing*

***Objective:** To demonstrate common mistakes that are often made as producers switch to a direct seeding system.*

Grain producers converting from a conventional seeding system to direct seeding may have difficulty adapting their seeding practices to the new system. The common errors focused on in this year's demonstrations were fertilizer placement in proximity to the seed, and rate of travel when seeding. In addition, Agrotain, a product which inhibits the breakdown of urea to carbon dioxide and ammonia was demonstrated. The product is applied as a liquid to the fertilizer which is then tumbled or mixed to ensure complete coverage.

A Flexi-coil 5000 air drill equipped with Stealth openers was used to seed the trials on May 25. Durum wheat and canola were sown. The canola suffered poor emergence, and that portion of the trial was abandoned.

Table 1. Effect of opener and nitrogen source on plant density and grain yield.

Opener	Fertilizer placement	N source	Plant density		Grain yield	
			#/m row	#/ft row	kg/ha	bu/ac
3" spread tip	seed placed	Agrotain	37	12	5778	85
	seed placed	46-0-0	33	11	5010	74
	side band	46-0-0	36	12	5053	75
3/4" knife	seed placed	Agrotain	26	8	4696	69
	seed placed	46-0-0	16	5	2770	41
	side band	46-0-0	33	11	5230	77

Fertilizer rates of 67 kg 12-51-0/ha (60 lb/ac) and of 225 kg/ha 46-0-0 (200 lb/ac) were applied for both the seed placed and the side band treatments.

Seed placement of high rates of fertilizer with either the 3 inch spread tip or with the 3/4 inch knife resulted in a thinner stand and lower yield (Table 1). Side band placement was equally effective with either opener (Table 1). Seed placed Agrotain coated urea had no effect on plant stand or yield with the 3 inch spread tip. When seeding with the narrow knife opener, the Agrotain treatment was intermediate to seed placed urea and side banded for both plant stand and grain yield (Table 1).

Increasing the rate of travel when seeding from 4.0 mph to 4.5 mph with the knife opener had no effect in this trial (Table 2). Increased speed led to both a slightly lower plant density and a lower yield when using the higher disturbance 3 inch opener.

Table 2. Effect of opener and ground speed at seeding on plant density and grain yield.

Ground speed	Opener	Plant density		Grain yield	
		#/m2	#/sq. ft.	kg/ha	bu/ac
4.0 mph	3" spread tip	36	12	5229	77
	3/4" knife	35	11	5096	75
4.5 mph	3" spread tip	32	10	4880	72
	3/4" knife	32	10	5002	74

[1]*Saskatchewan Soil Conservation Association, Saskatoon*
[2]*CSIDC, Outlook*