IMPROVED IRRIGATION MANAGEMENT

L. T. Bohrson, P. Ag. *

Conservation and development are complimentary goals in on-farm water management. The workshop theme of conservation is addressed in our program of improved irrigation management. However, development provides the parameters and an introduction to you of irrigation trends.

"Saskatchewan's most ambitious and co-ordinated assistance program for irrigation development is nine months old. Tangible returns to the teamed efforts of Saskatchewan Agriculture, Saskatchewan Water Corporation, and Agriculture Canada - PFRA, exceed initial expectations.

Six hundred and twelve farmers proposed development of over 55,000 acres on 692 projects. Through initial technical consultation, 573 new projects are actively proceeding. Of this group, 181 are held by Saskatchewan Agriculture for detailed agronomic services. The remaining 392 have advanced to the shared engineering services of Saskatchewan Water Corporation and Agriculture Canada - PFRA.

Saskatchewan Agriculture provides financial assistance of $100 per acre to farmers who develop new projects. Sixty dollars per acre is paid in the year of development and $20 per acre for the next two years. To date, 54 projects are complete with grants already paid on 6,023 acres. Total grant payments to date are $353,444. Developed irrigation projects average 111 acres in size.

1984's drought conditions created a renewed effort to develop and diversify the agricultural use of water in Saskatchewan. Irrigation brings greater stability to both our grain and livestock industry and, in turn, our provincial economy." **

As an introduction, this progress report regarding the priority of on-farm irrigation development may be a more familiar topic than the conservation objective of improved irrigation management. The fundamental objectives of improved irrigation management have been as follows:

- to introduce irrigation farmers to the use of advanced irrigation water management methods;

* Les Bohrson is the Senior Agrologists with the Irrigation Branch, Saskatchewan Agriculture, Outlook.

** Individual Irrigation Development Policy news release "Irrigation Assistance Delivered" February 7, 1985.

- to prepare irrigating farmers to evaluate irrigation practices where limited quantities and/or limited qualities of irrigation water are available; and

- to assist engineers and agrologists to improve irrigation standards for Saskatchewan's regionally different agro-climatic conditions.

In the past 3 years over 500 farmers have enrolled in a series of 19 2-day irrigation management seminars. Regionally this nucleus has provided 130 co-operators. A majority have represented high investment - high technology installations. In both 1983 and 1984 the scope of the program included a dozen different crops on about 15,000 acres. Forage, hard red spring wheat, soft white spring wheat and canola comprised 76% of the irrigated acres.

Enrolling, the irrigator agrees as follows:

- to supply a suitable soil sampling probe and rain gauge,

- to provide a record of irrigation and other production data, where requested,

- to allow field access to the branch during the growing season for group extension purposes, and

- to accept responsibility for damage of branch equipment resulting from the irrigators misuse or carelessness.

In turn the Irrigation Branch agrees as follows:

- to supply some soil moisture measurment equipment, if not already supplied by the irrigator,

- to assess each field on a regular basis throughout the summer, and

- to provide, for all methods after every visit, a handwritten summary of observations and a recommendation for the farmer's consideration.

Both in 1983 and 1984 nearly 300 summaries reported over 2400 site observations and delivered 1,000 recommendations to the farmers. A table of observation technics follows:

SOIL MOISTURE MEASUREMENT

Soil Sampling Probes - Clement's backsaver is highly recommended. Oakfield's Model B is the standard economy unit. Augers, spades, rods, etc. have limitations but are used. Identification of a wetting front with pivot irrigation is essential and requires a soil core sample.

"Feeling" Soil - Subjective, requires training and experience. Field spot checks and flexibility in selection of representative field sites is advantageous.

Gravimetric - Accurate for sample depending on bulk density estimation. Time and laboratory equipment required.

Tensiometers - Popular with farmers, accurate and fast. Portable in the field but require proper preparation and installation. Works best in loam to sandy soils.

Electrical Resistance Blocks - Accurate, fast and economical. Performs well with finer textured soils. The permanent installation and mineral nature of our soil is possibly limiting over time.

Neutron Probe - Accurate and precise readings depending on calibration and bulk density estimation. Expensive, cumbersome equipment is valued in research activities. Training is recommended, and licencing is required.

ENVIRONMENTAL FACTORS - Reasonably dependable, require accurate inputs and fast access to information from Environment Canada (temperature, precipitation, evaporation, solar radiation, wind).

Rain Gauge - Large opening recommended. Reveals a site specific application of irrigation and/or precipitation, seed with mineral oil to prevent evaporation, enables periodic observation.

Evaporation Tub - Fast with satisfactory results, compliments rain gauge monitoring. Use is limited to period of rapid crop water use and cannot accommodate periods of serious crop drought.

PLANT STRESS TECHNIQUES - Requiring Study

Infrared Thermometer - believed to be accurate and fast, sunny mid-day conditions preferred. Expensive and interface with data processing recommended.

Plant Moisture Stress Chamber - laboratory or field models measure plant moisture tension or resistance to water movement in the plant. Expensive and in the testing stage by Bryan Fowler.

Research in plant physiology and the disciplines of agrometeorology and remote sensing are expected to generate valuable new water management practices in the near future.

The Irrigation Branch and the irrigator mutually establish a clear understanding as to the training method to be followed.

Method 1 - field sampling, moisture determination, and recommendation.

Method 2 - Method 1 plus soil moisture equipment installation, monitoring by farmer and staff through season with recommendations.

Method 3 - Method 2 plus Check Book Method, improved recommendation and evaluation system.

Method 4 - Method 2 plus Plant Grow Computer Model prediction capability of crop, water and soil interaction and their affect on expected final yields.

Each successive method requires increased monitoring and recording of data by the farmer. Method 4 computer assisted irrigation scheduling requires high quality assumptions as well as input. The principles projected stand to be challenged and improved. The following is an example of Method 4 - Plant Grow Computer predictions in 1983.

Major Assumptions:

1. Wheat crop - seeded May 20
   - emerged May 28
   - rapid growth to July 1
   - head and flower to July 20
   - seed formation to August 14
   - ripening to September 6

2. Three foot root zone reaches field capacity on July 13, following two weeks of rain and pivot irrigation.

3. The long term average 3 inches of rain will be stored between July 14 and September 6.

4. The weather data represents that normal to irrigation farms in an area between Outlook in the north, Leader in the southwest and Estevan in the southeast.

Major Questions:

1. What will the soil moisture use be between August 1 and swathing (September 6)?

2. How much will this water use pattern reduce the expected yield potential?

TABLE 1: The Printout By Soil Type:

TOTAL Moisture Added July 14-Sept 6 To These Soils	RAM * Over .5"/ft Sand	RAM * Over .7"/ft Sandy Loam	RAM * Over .9"/ft Medium	RAM * Over 1.0"/ft Fine & Sticky
Only Rain (3.0")	2.4" - 44%	3.5" - 21%	4.6" - 8%	5.2" - 4%
Rain Plus Irrigation To July 25 (3.4")	2.9" - 37%	3.9" - 15%	4.9" - 5%	5.4" - 3%
Rain Plus Irrigation To Aug. 1 (4.3")	3.2" - 23%	4.6" - 8%	5.5" - 2%	5.8" - 1%
Rain Plus Irrigation To Aug. 8 (5.2")	4.1" - 13%	5.3" - 3%	5.9" NIL	6.0" NIL
Rain Plus Irrigation To Aug. 15 (6.1")	5.0" - 4%	5.8" NIL	6.1" NIL	6.1" NIL

* RAM - refers to the readily available moisture by volume in inches of moisture per foot of soil depth.

Example:

If you stopped pivot irrigation on August 1 your crop would only have drawn 3.2" of water from coarse sand and suffered a 23% yield loss. With the much better moisture holding capacity of a medium loam texture the wheat would use 5.5" of water while only suffering a 2% yield reduction. Soil texture rather than the calendar date is an over-riding factor.

Turning to 1984 our seeding dates were generally a week earlier and the general soaking rains of early July, 1983, failed to be repeated in southern and central Saskatchewan. Indicators of this drought were the increase in dryland crop insurance claims from 23,738 to 41,172, and payments to farmers from $105 million to $250 million in 1983 and 1984 respectively.

Cost increases to irrigators in offsetting the drought are indicated in the following Table 2 annual hours of electrical pumping by Saskatchewan Power Corporation. Note that farmers with a limited water supply are not able to compensate for drought by pumping more water.

TABLE 2: Annual Hours of Electrical Pumping:

Water Supply	1981	1982	1983	1984
Unlimited	755	665	583	1004*
Limited	354	317	352	397**

* 463 pumping installations were averaged.
** 40 pumping installations were averaged.

For farmers in 1984 with unlimited water supplies, pumping 1,000 hours and averaging 82 hp (continuous rating), the electrical cost was $3,000.00. If this were expressed by system, a 130 acre pivot with a lift of water from 100 to 120 feet high had a pumping cost of $23.00 per acre. With electricity at 4¢/kwh and diesel at 38¢/litre the cost of operating diesel was about 2.5 times greater.

Managing the moisture reserve in the upper root zone is critical. The presence of readily available moisture insures plant access to a quality array of nutrients with normally lower concentration of salts in the soil solution. Field scale uniformity can be greatly improved with periodic soaking rains. System design limitations were a factor in 1984's increased variability in moisture reserves by mid-July. For this reason average data does not reflect the range of conditions in any field.

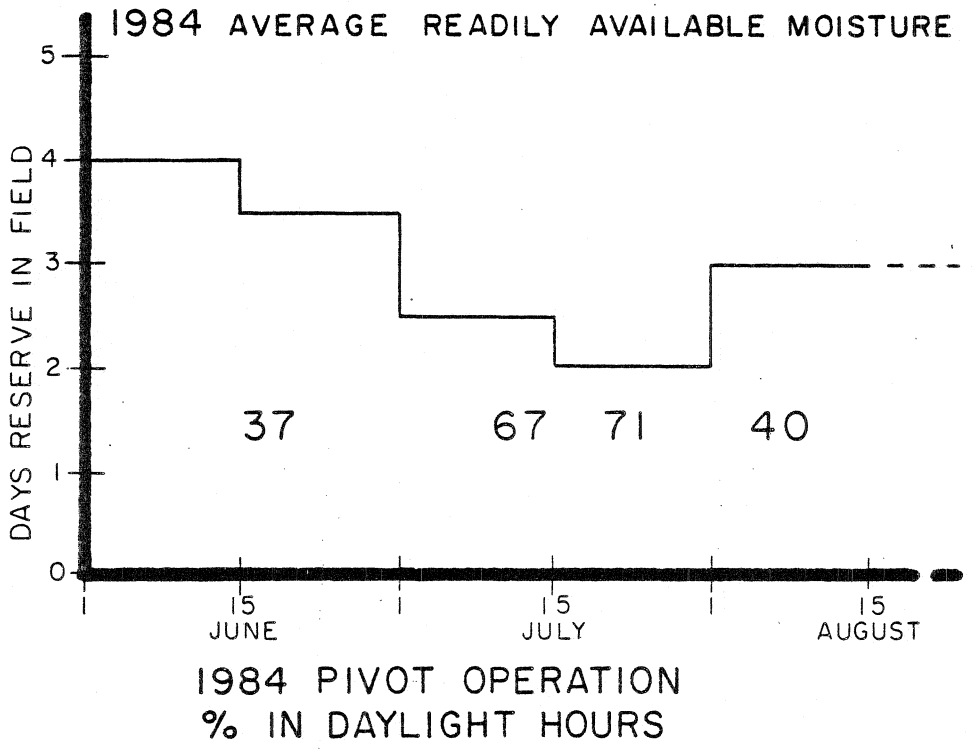
Figure 1 displays the observed strategy in moisture reserve management. A survey across Saskatchewan indicated pivots were irrigating the following percentage of the time, in daylight hours, between June 11 and August 9:

June 11 - July 1: 37% July 2 - July 15: 67%
July 16 - July 29: 71% July 30 - Aug. 9: 40%

The margin of reserve moisture readily available in the upper root zone decreased from four days to two days between mid-June and mid-July, but rebounded to about 3 days as crop moisture use declined in early August. Termination of irrigation must match crop maturation to the moisture reserve in the root zone.

The importance of soil probing to monitor wetting front penetration is now emphasized. The management of pivot irrigation differs from most theoretical research due to the higher frequency of soil wetting. Irrigation research requires the capacity to bring the root zone to field capacity. Pivots are designed to generate a local shower that lasts only a few miutes over a unit

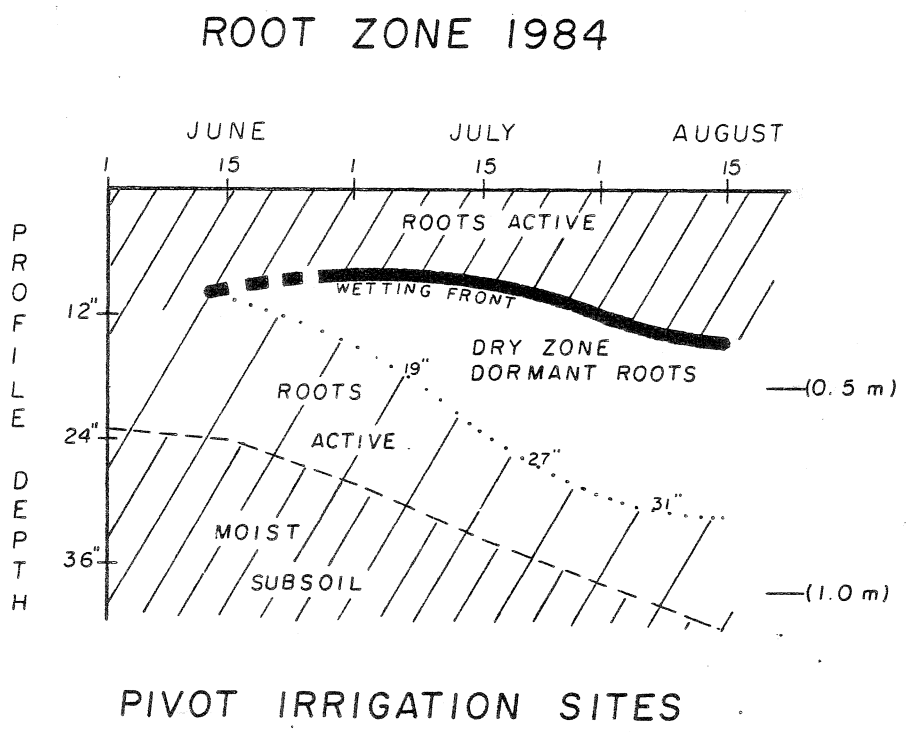
FIGURE 1



area of soil. The depth of soil wet to field capacity is determined by soil texture and range of moisture content.

Figure 2 relates mean data observed in 1984 and reveals the dilemma of wetting front management and root activity to profile depth. Until mid-June the design capacity for sprinkler irrigation can easily meet the crop's need and boost moisture reserves. Early irrigation can deliver a wetting front through dry subsoil not reached by fall or spring precipitation. Through late June and July wetting front penetration is limited, without precipitation to supplement system capacity. In 1984, the general wetting front penetration was limited from 12" in the third week of June to about 9" for most of July. Below the wetting front, a dry zone extends during periods of moisture stress to 19", 27" and 31" by the second week of July, the fourth week of July and the end of the first week of August, respectively. In this dry zone little available moisture remained and root activity appeared dormant. Below the dry zone, root activity resumed as moisture contents increased to readily available levels in the subsoil. This pattern was similar between the cereal grains and canola. Deeper penetration of the wetting front in coarse sands was recorded, however, moisture stress was also a greater risk.

FIGURE 2



Management by wetting front and targeting 24" penetration is an aggressive innovation in irrigation scheduling. It requires carrying an additional moisture reserve in place in early June through July. This, in turn, allows earlier termination of irrigation in August for annual crops.

Frequent shallow wetting fronts, with a little luck, produce expected yields. However, crop loss from mechanical breakdowns during July or late season stress during seed formation is expected.

Conclusion:

Good irrigation management requires constant re-evaluation of field conditions and their effect on plant growth. This program strives to enhance the technical expertise of irrigated crop management throughout Saskatchewan. Regional demonstrations and field tours involving extension personnel and farmers reinforce the practical training and application of this extension program. As an appendix the 82 irrigators listed demonstrate the diversity of irrigation in this program. Their willingness and co-operation in sharing our objectives was most appreciated. We want to especially thank the hosts of our 13 summer field days, which allowed participation by some 280 other farmers and agricultural advisors in 1984.

IRRIGATION MANAGEMENT CLIENTS - 1984

NAME	ADDRESS	SYSTEM	SIZE **	WATER SUPPLY
Agar, Roland	Consul	Border Dyke	25	Cypress L. Canal
Ailsby, Howard	Simmie	Pivot	130	Duncairn Dam
Bergman, Vic	Elbow	Pivot	133	Dief. Lake
Bond, Roger	Donavon	Pivot	130	South Sask River
Bouvier, Richard	Coderre	Pivot	136	Chaplin Creek
Buhr, Harold	Lucky Lake	Pivot	177	Macrorie WM 1
Creech, Barnie	Lloydminister	Pivot	143	Effluent
Dahl, Randy	Broderick	Pivot	130	SSRID #1
Delyea, Garth	Assiniboia	Pivot	220	Effluent
Dyck, Herman	Lucky Lake	Pivot	500	Dief. Lake
England, Lyle	Central Butte	Pivot	332	Dief. Lake
Ewen, Dale	Riverhurst	Pivot	135	Dief. Lake
Ewen, Don	Moose Jaw	Pivot	133	Effluent
Fehr, Peter	Osler	Pivot	97	South Sask River
Fogal, Bud	LaFleche	Pivot	133	Wood River
Follick, Gerald	Outlook	Pivot	111	SSRID #1
Follick, Terry	Strongfield	Pivot	130	SSRID #1
Fox, Don	Moose Jaw	Pivot	133	Effluent
Fraser, Ian	Pambrun	Pivot	140	Farm Dams
Friesen, Dave	Osler	Pivots	260	South Sask River
Friesen, Jake	Osler	Pivot	130	South Sask River
Gaucher, Louis	Coderre	Pivot	172	Wood River
Goby, Russel	Avonlea	Pivot	133	Avonlea Creek
Grainlands	Central Butte	Siderolls	1283	Dief. Lake
Bob Chapman, Cal King, Ken May				
Grant, Lynn	Val Marie	Border Dyke	80	Val Marie Dam
Haraldson, Ed.	Hanley	Pivots	528	SSEWS
Harder, Don	Dundurn	Pivot	132	SSEWS
Harder, Elmer	Dundurn	Pivots	262	SSEWS
Harder, Vernon	Hanley	Pivot	170	SSEWS
Howe, D & D	Moose Jaw	Pivot	133	Effluent
Hundeby, Art	Elbow	Pivot	133	Dief. Lake
Hunt, Arnold	Moose Jaw	Pivot	133	Effluent
Joel, Harvey	Elbow	Pivot	50	Dief. Lake
Kelln, Marvin	Strasbourg	Pivot	180	Last Mount Lake
Keyser, Harold	Cupar	Pivot	134	Cupar Reservoir
Knock, Wayne	Hanley	Pivot	130	SSEWS
Larochelle, Jules	Ponteix	Border Dyke	30	Gouveneur Dam
Larson, M & R	Outlook	Pivot	324	SSRID #1
Lauder, Robert	Craven	Sideroll	45	Qu'Appelle River
Lawrence, Eric	Maple Creek	Border Dyke	30	PFRA, Maple Creek
Lee, Larry	Outlook	Pivot	200	Macrorie WM 1
Mathies, Ron	Herbert	Pivot	385	Herbert Reservoir
Miry Creek	Cabri	Sideroll	1590	Dief. Lake
Rick Bos, Glen Dokken, Glen Horvey, Wayne Murch				
Morvick, Lester	Eastend	Border Dyke	30	Eastend Reservoir
Nelson, Bob	Lloydminister	Pivot	150	Greenstreet Lake
Obrigewitsch, Rod	Craik	Pivot	200	Arm River
Ofstie, Gordon	Glenside	Sideroll	129	SSEWS
Ollen, Dave	Lloydminister	Pivot	210	Greenstreet Lake
Oram, Kerry	Central Butte	Pivot	133	Dief. Lake

Oram, Murray	Central Butte	Pivot	133	Farm Dam
Perrault, Andy	Ponteix	Border Dyke	50	Gouveneur Dam
Perrault, Paul	Ponteix	Border Dyke	50	Gouveneur Dam
Purcell, Dwight	Saskatoon	Pivot	166	South Sask River
Raffard, Stan	Clavet	Pivot	519	SSEWS
Richard, Trent	Assiniboia	Pivot	133	Slough
Richmond, V & B	Gravelbourg	Pivot	133	Wood River
Sadler, Art	Riverhurst	Sideroll	60	Dief. Lake
Schneider, Cliff	Estuary	Pivot	130	South Sask River
Senger, Jack	Allan	Pivot	112	SSEWS
Semans, Carl	Rush Lake	Pivot	130	Highfield Canal
Simonson, V & N	Dunblane	Pivot	440	Dief. Lake
Soggie, Stan	Elbow	Pivot	100	Dief. Lake
Thompson, Neil	Riverhurst	Pivots	320	Dief. Lake
Tittle, Ron	Consul	Border Dyke	30	Cypress L. Canal
Twemlow, Trevor	Assiniboia	Pivot	133	Limerick Slough
Vestre, Allan	Outlook	Pivot	180	SSRID #1
Voice, Les	Bradwell	Sideroll Pivot	182	SSEWS
Ward, Elmer	Birsay	Pivot	130	Dief. Lake
Webster, B & G	Imperial	Pivot	115	Last Mount. Lake
Weiss, Warren	Maple Creek	Border Dyke	60	PFRA, Maple Creek
Wollman, M & D	Dundurn	Pivots	1006	SSEWS

** Size in acres refers only to the systems where soil moisture equipment was installed, not necessarily the farm's total irrigation.

* * * *

IRRIGATION BRANCH OF SASKATCHEWAN AGRICULTURE

Branch and Program Management

H. A. (Harvey) Fjeld - Director, Irrigation Branch

T. W. (Tom) Hamlin - Irrigation Economist

L. T. (Les) Bohrson - Senior Agrologist

M. G. (Marlene) Knopp - Administrative Officer

Soils Investigation Section

G. W. (Garth) Weiterman - Senior Soils Agrologist and Head of Soils Investigation Section

M. B. (Morley) Sinclair - Irrigation Technician

Field Services Section

G. P. (Gerry) Gross - Irrigation Agrologist and Acting Head of Field Services Section

J. L. (John) Linsley - Irrigation Agrologist

W. J. (Bill) King - Irrigation Agrologist

S. S. (Steve) Pawlus - Irrigation Technician