THE WINSTON CHURCHILL MEMORIAL TRUST

OF AUSTRALIA

Report by – Jeff Patterson – 1999 Churchill Fellow

Project: To study dryland salinity control using Lucerne, particularly the methods used to regulate ground water over whole catchments

(PHOTOS PROVIDED ON HARDCOPY REPORT ONLY – HELD AT TRUST)

EXECUTIVE SUMMARY

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Project Description:
To study dryland salinity control with Lucerne, particularly the methods used to regulate ground water over whole catchments.

Highlights:
Montana Salinity Control Association (MSCA)
Based in Conrad Montana USA, headed by Jane Holzer acted as great hosts. With their help I was able to access relevant data. They were also instrumental in showing me some of the successes of their programs along with the unfavorable outcomes of drainage into Benton Lake. Jane Holzer also connected me with her Canadian counterparts. A joint field trip to the border with MSCA and Alberta Agriculture highlighted the need for cross boundary cooperation.

Alberta Agriculture, Food and Rural Development
Lethbridge Canada, Don Wentz and team were able to present the Canadian view, along with several field trips.

Agriculture and Agri-Food Canada Research Branch
Semiarid Prairie Agricultural Research Centre, Swift Current Saskatchewan, Canada
Here my gratitude goes to Harold Steppuhn and colleagues. Points of interest were, a water harvesting drainage trial and the salt testing lab. The salt testing lab is a two story building designed and equipped to evaluate salt tolerances of plants.

The University Of Arizona
Tucson Arizona, Steven Smith was most helpful with information on screening of plant material for salt tolerance past, present and likely future. As a bonus I gained greatly from a field trip into the dessert with Steven and Bruce Munda from Natural Resources Conservation Service to collect seed.

While it was encouraging to find that both the Americans and Canadians have developed an effective system to reduce and control salinity. My belief that Australia is at the cutting edge of environmental management was challenged very quickly. It would appear that we are some 15 to 20 years behind both these countries. The use of Lucerne and flex-cropping are considered best practice and widely used. Here, the adoption of Lucerne is still slow and often meets with scepticism. Both countries have tried drainage. In recognition of lesser results and unacceptable downstream impacts this practice is no longer used. In light of these countries experiences we would be best advised to concentrate on the widespread adoption of Lucerne and rotational cropping. This fits with a saying I heard in America “No reclamation is permanent without a change in land usage”. Other interesting terms they used were Nonpoint Source Pollution (NSP) by this they acknowledge that salinity is a pollutant from a wide source and a rising water table is called Sub Irrigation suggesting an asset rather than a costly problem. The fast adoption of high water usage sustainable farming in the United States of America has been helped by strong financial government support. Salinity impacts not just on the environment but communities and the economy. Without strong financial support such as the American farmers receive, Australian farmers will battle to achieve the successes of the American farmers.

Montana has turned out to be a very good choice as an area to research salinity control. The greatest amount of the USA's salinity problems and therefore research and practical work is found here. Even though the USA has less salt affected area than Australia it has still put much effort and resources into land management practices. At this point in time it is Montana Salinity Control Association (MSCA) that helps land users with salinity problems.

With the need to address the increasing problem of salinity, farmers in 10 Soil Conservation District's joined in 1979 to form the Triangle Conservation District. After becoming a legal entity and receiving a grant from the Montana Renewable Resource and Development Program a project to demonstrate the feasibility of using a trained field team to provide on farm assistance commenced. This was a 3-person technical field team based at Conrad Montana. Their brief was to locate recharge areas, collate data and information to assist farmers in controlling and reclaiming saline areas. As a result of this project's success it was expanded to cover 34 counties and is now known as the Montana Salinity Control Association. MSCA has an executive board elected by and from the conservation districts. The board provides guidance to staff, determines priorities, works with agencies and helps secure funding.

At first the MSCA worked mostly with individual landholders, sometimes two or three as ground water is not confined by cadastral boundaries. It was soon learnt that success was dependent on cooperation and often cooperation depended on neighbors sharing the same salinity problem. As is the case here in Australia often recharge for a discharge area is found on a different property. Difficulties arise with this scenario as one farmers practices need to change to affect reclamation of another farmers property. Not only is cooperation needed between farmers, Countys and States, but also Countries, as catchments cross International boundaries. To achieve a successful outcome both farmers need to be placed in a win-win situation. From this evolved the concept of Watershed Planning.

In 1989 a farmer in Pondera County approached MSCA requesting assistance to reclaim a large saline area. Due to the size of saline seep, topography, combination of irrigation and non-irrigation land use, it was quickly realised that many different landowners were involved. This signaled a need for a new approach. The project became the Bullhead Water Quality Project. The Bullhead Watershed or Catchment covers 64000 acres (25910 ha) of which 2500 acres (1012 ha) are at risk from salinity. In view of the change to, whole of catchment approach, a new government funded program was developed to finance ground water investigation and long term planning. Farmers of the Bullhead area formed an association, elected a committee and generated funds to cover administration expenses and in-kind matching requirement with a self levy. Once again success with this project has seen the concept expanded to help other areas. Among the many projects now in place are notables such as the Lake Creek Partnership, Red River Watershed and Sage Creek Alliance, they range in size up to 625000 acres (253036 ha) with 30000 acres (12145 ha) of saline land.

MSCA in conjunction with dedicated farmers and researchers have shown great skill to overcome obstacles in an effort to control salinity caused by poor farming practices.

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Since the start of what is now known as MSCA they have refined their preferred method of operation. The focus is always on salinity control but not at the expense of farm viability. Having a multi skilled team ensures the ability to handle the most difficult situation. Time has also shown a need to be able to change, adapt, mix and match as new ideas and situations arise. MSCA have risen to this challenge and excelled.

The system that MSCA now employs is simple and effective, following a step by step plan. It is more common for a group of farmers to request assistance now than an individual. Once MSCA becomes involved the plan starts at step one whether it be just one farmer with a self-contained ground water system on a small area or many farmers covering a large area. Step one is to define the watershed and list all landowners and land users. In accomplishing this first step the size of the catchment becomes known.

Step two is a general survey of the area to establish land usage, size and severity of the salinity. At this stage history of the area is gathered, whether it be verbal, written, mapped or photographic. The history is built up from local data and supplemented with government documentation. One of the most important pieces of information in this step is the periodical Aerial photographs.

Step three is to conduct a hydrological survey of the area, from the top of the recharge area to the bottom of the discharge area. From this data a ground water contour map can be created. At this point all base data has been put together and planning can start.

Step four is the planning step. This involves all land usage within the area, whether it is irrigation, dryland cropping or rangeland farming. It is commonly suggested for a large area of the recharge to be planted to Lucerne, either as a pure stand or mixed with grasses. These stands usually stay in place for 8 to 10 years, by this time ground waters have been controlled. Once control is gained the Lucerne can be removed and replaced with flex cropping. Usually the remainder of the recharge area is designated for flex cropping. In some cases some recharge land will be permanently planted back to rangeland. The recommended action for land in the discharge area that is unsuitable for cropping until recovery has been effective would be planting to salt tolerant pasture species, with a view to hay production. As this land recovers the salt tolerant plants will give way to flex cropping.

Over time key observation wells that were put in for the hydrological survey will be identified and monitoring of these will continue long after the others have served their purpose. The main observation well or wells will be in the discharge area. A rise in the water level in these wells is a signal for another planting of Lucerne. This secondary planting is usually smaller in size and stays in for a shorter time. To achieve this reduced planting key recharge areas must be identified and targeted. Recordings of observation wells are made by the farmers, and the data is passed on to MSCA to be entered into the file along with all other information collected on that project.

Each project has its own file, when MSCA staff work on the project or have contact with the landowners notes are made in the file. As a result a great depth of information is built pertaining to individual catchments.

Step five is the implementation of the recommended program. To facilitate implementation MSCA helps the farmer and or group find the best suited funding program and make an application to secure finance. From here on MSCA's roll becomes more of a record keeper and reminder to the farmers to monitor observation wells. However, MSCA still find time to travel out to projects from time to time and keep an active contact with all farmers they work with.

Research work in the late 1960's by Marvin Miller, Hayden Ferguson and Paul Brown on the Highwood Bench area of Chouteau County documented that long term use of 50/50 crop/fallow significantly contributed to rising ground water tables and salinity. Farmers had several reasons for using this system. One reason for the fallow being moisture retention for the next crop .By doing this not all precipitation could be stored and used by the crop, the excess leaks through to deeper ground water systems. It is this unutilised water or leakage that goes on to be the problem. Jim Sims and Jim Krall, in 1968, suggested new cropping systems to replace crop/fallow. By 1971 this became known as "Flexible Cropping". Work over ensuing years, helped refine this concept to meet landcare and farmer needs. Even today new crops and agronomic ideas are being woven into this concept to give Flex-Cropping more versatility and economic strength.

From here public research institutions looked to establish longer cropping rotations for better water utilisation. Deep-rooted perennials were brought in to the plan and planted on critical recharge areas to extract ground water, which had leaked past the root zone of small grain crops. Lucerne/alfalfa (Medicago sativa) being a high water user and able to root to great depth fitted the criteria well. While work at developing salt tolerant Lucerne continues, its best place of use is middle and upper slope. Even if good salt tolerant lines are developed the majority of Lucerne plantings will probably still be middle and upper slope.

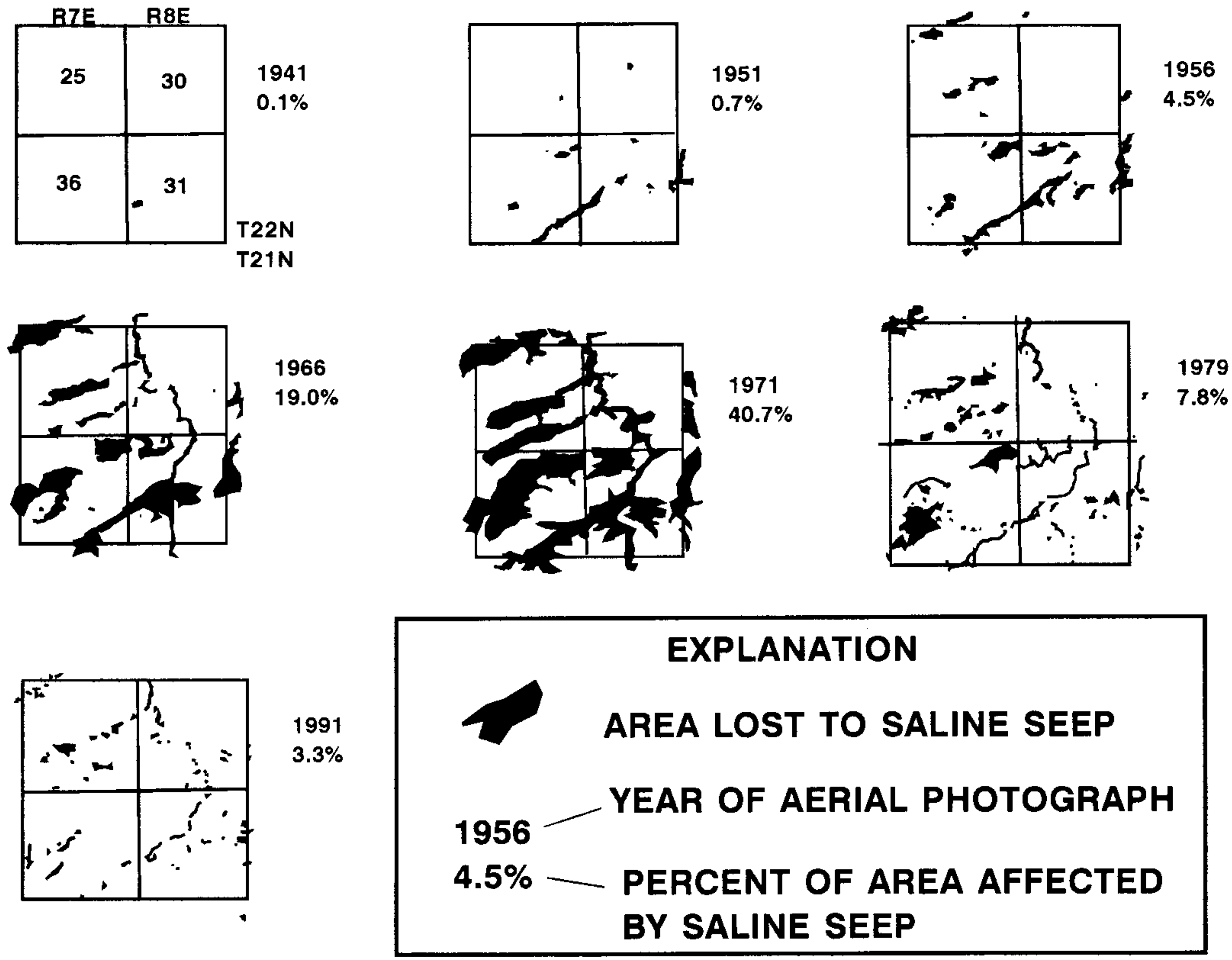
In order to attain maximum benefit from Lucerne planting it is desirable to include lands with the highest water table elevation. This requires a hydrological survey generating a ground water contour map as ground water contours don't always follow land contours. The size of planting is dependent on the size of saline seep or seeps and desired speed of recovery. Recharge area to discharge area average a ratio of 10:1 needing Lucerne plantings around the same ratio. Recovery can be as short as 5 years with 80-100% of recharge area planted to Lucerne. A Flex Cropping period can then be enjoyed for some time often up to 17 years. When ground waters once again start to rise in the discharge area, small areas of highest recharge can be replanted to Lucerne in order to extend the ground water balance period.

Some farmers opt for pure stands of Lucerne for agronomic reasons and to meet market demands. Primarily these stands are cut several times in a season for the hay and chaff market. Other farmers choose to have a mixed stand of Lucerne and grasses to qualify with government program guidelines. It is apparent that whether stands are highly managed or unmanaged their effect on ground water systems is the same or very similar.

Highwood Bench of Chouteau County provides a good case study due in part to research work on salinity in the 1960's conducted in that area. The area comprises some 100,000 acres (40,486 ha) of relatively flat and gently sloping grass plains with an occasional sharp drop into a gully or draw.

Early land use of the area was open grazing, firstly by native herds of bison and other grazing animals. Then came the Europeans with cattle and horses but still with open ranch grazing. The 1930's and 1940's saw a big change from just ranching to intensive agriculture or farming. To this point it was considered that less than 1% of the area was affected by salinity. After the start of farming the increase in land lost to salinity grew quickly. Land lost to salinity peaked at 40.7% in 1971. From this point with good practices in place land once lost was reclaimed faster than it was lost. By 1991 the amount lost to salinity was back to 3.3%. Farmers in the Highwood area are comfortable with salinity at this level as they have confidence in their sustainable system.

Photos Page (6), Map Page (7)



Rate of growth of a saline seep in a 4 square mile area of Montana (1941-1991).

The government of the USA provides valuable financial assistance to farmers ensuring their viability while protecting valuable resources. Several programs are available to farmers or groups of farmers and land users. MSCA is able to direct farmers and catchment groups to the relevant agency with the progamme that best suits their needs.

Environmental Quality Incentive Program (EQIP) is designed to provide cost share for individual ground water investigation. Funds are also provided to encourage the adoption of more efficient cropping systems in recharge areas. This can include a range of options that reduces a farmer's dependency on the strict crop-fallow system and associated problems. These funds are competed for within each state allocation. Applications are prioritised and funded in order. A farmer need not control both discharge and recharge areas. Another benefit from this program is the incentives given for adjoining landowners that work together solving salinity problems.

Conservation Reserve Program (CRP) provides a ten-year contract for landowners to plant down land to perennial forages, that was previously used for cropping. These contracts provide annual payments for land exclusively set aside for landcare. Farmers can only cut hay or graze livestock on CRP lands in the event of a nationally declared emergency. When CRP was first introduced land could be planted to a single grass species, now a mix of 3-4 grass species and one or more legume species are required. Even though CRP lands are left unmanaged, not even slashed, they mimic the effect that pure Lucerne stands have on ground water tables. Within this program there is a special section to enroll recharge areas that may otherwise miss out.

Water Quality Incentive Program (WQIP) is aimed at improving water conservation practices. The target is to reduce Non Point Source (NPS) agricultural pollutants. Payments vary in size and number of annual installments. Small annuities over three years for Flex Crop and larger payments over five years to grow Lucerne. The total amount that a farmer can receive is relatively low as it is regarded as an incentive only.

Upland Game Bird Habitat Enhancement Program (UGBH) is the most prominent of a plethora of smaller funding programs in Montana. Funding covers all costs of establishment of a 5 row tree/shrub shelterbelt, fencing and water development. In this program funding is not large but it all helps.

There are many other small, government and privately funded incentive programs that individual farmers and community groups can access for environmental projects.

While there are some big environmental differences between Montana and Western Australia there are also some marked similarities. Annual precipitation on average is comparable but the Montanan total comprises half rain half snow. Montana has snow and freezes during winter and a wet mild summer. Western Australia has a contrasting wet mild winter and very hot dry summer. The soils are different. Where Western Australian topsoil's are shallow over clay and rock. In many cases these topsoil's are either all clay or very high in clay content. The soils of Montana do not have the clay content and are free draining. Topsoil depth is usually much greater over Colorado and Bearpaw shale. In both cases it is accepted that salinisation has resulted from the removal of the natural vegetation and the implementation of farm practices that use less precipitation. I noted that the interval between natural vegetation removal and rapid increase of salinity was similar or the same for both environments. It is this land usage change that has created an imbalance. By modifying farm practices farmers of Montana have been able to establish an acceptable equilibrium.

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Many people look at solving salinity issues at the site of the problem and further down. MSCA have shown that the best effects come from work implemented above the saline seep area. They compliment this work with vegetative suggestions for the land around the seepage and as far into the salt affected land as plants will grow. By introducing plant species more suited to a salty environment further gains can be made. Having something growing on once baron ground aids in total landscape water use and provides the farmer with an opportunity to earn income. Also instead of an ugly scare the landscape looks more natural. Depending on the situation the areas planted to salt tolerant species may remain, be reduced in size or removed altogether so as to return to cropping. The most prevalent action is a reduction in size to permit more cropping, with the residual managed for hay production.

While most use of salt tolerant crops is made in and around salt seepage's most of these species grow well in ground not affected by salinity. This gives an opportunity for a farmer to diversify into seed production of these crops. A good example of this is a farmer at Milk River Canada who has devoted his whole crop enterprise to such seed production. As a result of this change he has enabled salinity control and at the same time increased profitability. By planting whole fields to salt tolerant grass good long-term water management is achieved, and the spread of salinity is controlled.

One of the first questions a farmer asks about a new crop is "Where will it grow?" or "What will it tolerate?" To answer these types of questions researchers need to separate variables and measure differences. It may even be desirable to monitor combinations of variables.

A solution to this problem is found at Swift Current Canada where a salt tolerance-testing laboratory has been built. The laboratory is a two story building with the upper floor being a controllable greenhouse. Different pots, trays, tubs and tanks are used in the greenhouse for germination, seedling and mature plant containment. These vessels are individually linked, by tubing, to separate brine tanks down on the lower floor. Tanks can be filled with differing solutions. The flow of solution to and from each vessel can be controlled and monitored.

Very few testing facilities of this calibre exist throughout the world. So far a number of different crops have been evaluated in this facility. These include barley, spring wheat, durum, canola, field pea, pinto bean, quinoa, kochia, flax, alfalfa / Lucerne, Sweetclover and many perennial grasses.

The agronomy of growing Lucerne or alfalfa, as they know it in the USA and Canada is similar. Their soil types are well suited to growing Lucerne and combined with wet summer produces well once established. Predominantly Lucerne is grown as a hay crop and cut a multiple of times over the summer. A different group of varieties are grown in this region to cope with winter freeze. Due to the winter freeze the last hay cut must not be too late in the season, as healthy regrowth is needed to survive through winter. Problems such as weed competition in establishment do not appear as critical. Lucerne seams to establish under weed such as Kochia. As a second year stand the Lucerne out competes the Kochia.

Lucerne is seen in the USA, Canada and Australia as, at best, only mildly or moderately salt tolerant. Plant breeding to improve this tolerance has seen some gains. With many different variables in a saline environment and between salt tolerance at different growth stages new varieties are aimed at specific niches. Most of the salt tolerance work has been designed for use in mild saline irrigation due to most Lucerne being grown this way. While Lucerne will remain best placed in the recharge area it will be advantages to have productive growth of Lucerne in saline areas. To achieve this goal, further development in salt tolerant varieties is imperative.

Just like here in Western Australia, increased drainage was suggested and tried as a land management practice. It was quite a popular idea for a short time but has now lost favour with all people involved in landcare in both Canada and the USA.

The methods used in North America for drainage differ from those used in Western Australia. Here open trenches about 2m or 6ft are dug through the salt affected area usually in or following the natural surface drainage line. The spoil is placed along one side of the drain as a bank. The North Americans use tiled drains. This term comes from when slotted earthen or terracotta pipe was used. With the change to plastic pipe the name stayed but the pipe used became perforated coiled plastic pipe. This pipe is laid or sown so as to permit normal farm practices to continue over the top. It is lain in a herring bone fashion with the main trunk line running off to a natural surface water drainage way. Both systems rely on ground water finding its way to the pipe or trench before coming to the ground surface. Once in the pipe or trench the saline water is conducted away to a disposal site.

It is apparent that both systems suffer similar problems. Soils vary greatly in their permeability. One variant caused by the clay content, as the percentage of clay increases water movement slows. It is also recognised that groundwater is able to move more vertically than horizontal. With such constraints the effect outward from the drain and volume of water moved are limited.

Moving water can carry many things, not just salts. Silt in drainage systems must be addressed. Good design of drains should minimise the depositing of silt. Inevitably build-ups of silt will occur requiring periodical maintenance.

By far the greatest problem associated with drainage is the offsite impacts. Extra water, salts and other nutrients taken from one place often impacts adversely on the place of discharge. Often the discharge sites chosen are suffering the same degradation pressures as the area to be reclaimed. Of even greater concern is when drainage waters are discharged into fresh areas such as rivers, lakes and streams. For a single drain, if the volume of salt and nutrients is low in comparison to the receiving body little or no effect may be seen. As the ratio of salt and nutrient to the size of the receiving body changes due to larger or a multiple of drains, effects become more obvious. In the Northern Great Plains there are a few natural salt lakes. These are closed basins with no natural outlets. The salt content of this water may exceed that of the ocean. The rivers and stream of this region are fresh, some starting in the Rocky Mountains. These rivers flow great distances through prime agricultural lands before reaching the sea. Along the way water is used for recreation, fishing, irrigation, live stock, domestic and industry. With such dependency on these rivers protection is of great concern.

An example of the damage that a man made drainage system can cause was shown to me just north of Great Falls Montana. A network of tile drains had been laid by a group of landowners with the discharge point being Benton Lake. After a period of time it was discovered that the salt levels of the lake water where rising. Salinisation continued till it was found that it was causing abnormalities in the bird life of the lake. As a short term remedy to save the bird life, fresh water was pumped in via a canal to dilute the salts coming in from the drain. In 1998 the pumping of fresh water into Benton Lake cost $50,000 US for diesel fuel, let alone set up costs and labour. Some farmers had already abandoned their parts of the drain, but in early 1999 one farmer was still maintaining and using his part of the network. By late 1999 the property with the last working piece of drain was set to change hands and abandon this practice. With a change from drainage to Lucerne and flex cropping over the whole catchment it will be interesting to see the natural recovery of the lake.

To achieve safe reliable river water supplies water quality acts have been put in place. This gives standards to be met and a legal basis to bring conformity. In short, salt is seen as a pollutant and if drainage water compromises the quality of the receiving body then permission to drain is denied.

A notable variation to the standard system is a project at Swift Current in Canada. The project is titled Combining Subsurface Drainage and Windbreak Technologies to Abate Salinity. In this environment windbreaks are employed to trap snow that would otherwise be blown away. When it melts it irrigates the soil, so the more snow trapped the more water enters the soil. More water leaches the salt out. The big difference with the drain is that at this site the water is collected to create a fresh water source. The farmer is able to utilize this water for farm crop spraying and at other times to irrigate trees. The key to success here lies with the fact that the water is used.

Acknowledgements:

Churchill Fellowship Trust
It has been both a privilege and an honour to receive a Churchill Fellowship. I am grateful to both the Trust and The Western Australian Association of Fellows for their support of my Study.
I believe that my Fellowship has been successful on a personal basis and also for the agricultural community.

Montana Salinity Control Association, Conrad Montana, USA
I would like to thank the MSCA for the many weeks I spent with them. Their help and hospitality was pivotal to the success of this Study.

Jane Holzer:
This Fellowship evolved out of a visit from Jane to my property in 1997. In her capacity as Director of the MSCA Jane organised much of my tour and placed me in contact with many interesting people and places.
My thanks to Jane also for the extra time she put in to welcoming me to Montana and making my free time memorable.

Alberta Agriculture, Food and Rural Development, Lethbridge, Canada:
My sincere thanks to Don Wentz and staff for hosting me professionally and socially.
Particular thanks to, Curt Livergood, Arva Traynor and Debbie for a memorable stay at Lethbridge.

Agriculture and Agri-Food Canada Reasearch Branch
Semi Prairie Agriculture Reasearch Centre, Swift Current, Saskatchewan,Canada
Harold Steppuhn and colleagues offered great support for this Study.

I wish to thank all the Farmers and Ranchers and families I met for their warm welcome and hospitality during my stay.

University of Arizona, Tucson Arizona
Thanks to Steve Smith for a brief but memorable time spent in Arizona. Also for the field trip into the desert.

Thank you to my Referees Lisa Blacklow of the Western Australian Lucerne Growers Association and Tom Bickley Postmaster Dumbleyung for your valued support.