THE WINSTON CHURCHILL MEMORIAL TRUST of AUSTALIA

The Ron Badman Family Churchill Fellowship
CHURCHILL FELLOWSHIP 2003

Incorporating lucerne and other deep rooted perennials into a continuous cropping dry land farming system without stock.

John Young – 2003 Churchill Fellow

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Acknowledgments

I would like to thank Mr. Ron Badman for sponsoring my fellowship and being a source of inspiration for the Churchill experience. Having had the pleasure of meeting Mr. Badman and his family, I am truly grateful.

Thanks also to Sharon Dawson and the Western Australian Lucerne Growers' Association for their support of my project and assistance with the application and travel arrangements.

Harold Srepphhun for his assistance with the Canadian leg of the tour and insights on the issues in North America.

Finally to my family for allowing me to take two months away from our farm in a critical time of the year and for having the confidence in me to achieve. Thanks John, Leonie and Ruth.

1. Executive Summary

Name: John Young
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Fellowship Objective
To investigate the role of deep rooted perennials in North American farming systems.

Fellowship Highlights

- Ronald Doetch – Executive Director Michael Fields Institute, East Troy, Wisconsin, US. Conservation security program, Japanese forage demands, US subsides.
- Walter Goldstein – Research Director. Lupin, clover and medic breeding, organics, using cover crops to reduce weed pressure.
- Prof Dwayne Beck – Director, Dakota Lakes Research Farm Pierre, South Dakota – USA. Ecosystem management, rotational phase farming using perennials and sustainability.
- Prof Martin Entz – Director Research cropping systems. University of Manitoba, Winnipeg – Canada. Cropping system trials, rotations using Lucerne, weed management, organic systems and cover cropping.
- Harold Steppuhn – Research Scientist Salinity. Swift Current, Research Station, Saskatchewan – Canada. Salinity, ground water trials.
- Dr Surya Acharya – Research Scientist and forage breeder. Lethbridge Agricultural Research Institute, Alberta – Canada. Perennial rye, anti bloat genetics, salt tolerance foe lucerne and forage directions.
- Dr Jill Clapperton – Soil Microbiologist. Lethbridge Agricultural Research Institute, Alberta – Canada. Cover crops, farming systems and soil health under long term rotations.

Key Findings

- Water use in farming systems needs to be matched to the native environment.
- Perennials need to be included in cropping rotations in a phase system.
- Long term benefits of lucerne as a rotational crop are still being discovered.
- State and federal Government need to be more supportive of Landcare with and economic gain to farmers
- Australian farmers must continue to be aggressive adopters of technology
- Sustainably driven farming systems need to be marketed and products differentiated.

Seminars

Invited seminar presentations into the role of deep rooted perennials in North America will be made at:

- Western Australian No Tillage Farming Association Annual conference, February 2005.
- Western Australian Lucerne Growers annual Field Day, September 2005

2. Introduction

Salinity currently affects approximately six million hectares of agricultural land in the southern areas of Australia (CSIRO 2003), with predictions that this will rise to over 15 million hectares before equilibrium is reached. Soil acidity seriously affects about 20 million Hectares of arable land and can reduce yields of sensitive crops by up to 50% (CSIRO 2003). Both these problems can be traced back to the clearing of farm land and the replacement of deep rooted perennials with short season annuals such as wheat.

Under native vegetation the deep root zone was able to capture nearly all of the water and nutrients, however annual cropping has allowed the leakage of water through the soil profile. This leakage action leaches nutrients from the soil causing acidification and finally rising ground water, bringing with it dissolved salts and rendering the land unproductive for annual cropping.

It is essential that if we are to find a sustainable balance for agriculture in Australia that more deep rooted perennials be included into our farming systems. The aim of this project is to explore the ways in which the North America farming systems are utilizing perennials and how they have evolved the agricultural ecosystem to match the water use of the native ecosystem.

The North American area that this study will concentrate on is known as the Northern Great Plains (NGP), this includes the three Canadian Prairie Provinces of Manitoba, Saskatchewan and Alberta, and the three US states, of North Dakota, South Dakota and Montana. The remnant vegetation found in these regions differ from Australia in that the prairie lands are traditionally treeless and are native grass lands containing both perennial and annual grasses. The move to a more annual cropping system here has also created salinity, water logging and a drop in soil organic carbon levels.

3. Program

See attached (appendix 1.1)

4. Agronomic

Perennial Forage crops in the Northern Great Plains (NGP)

There is considerable interest across the NGP in developing cropping systems that reduce the use of pesticides, protect the soil from erosion, improve soil quality, and reduce reliance on external inputs of non-renewable energy. Over 16 % of the arable farming land in the NGP is sown to forage perennials (Ag Canada 1999), Alfalfa (lucerne) is over 60% of this area with the remainder being native grasses. The forages are mainly used in the form of silage and are transported to feedlot animals. Very little lucerne is grazed in the field as bloat is considered a serious issue.

Forages are normally included in the farming system in a 4-6 year phase, followed then by 4-6 years of annual crops. This system is one which most closely represents the water use of the native ecosystem. The practice of shortening the rotation to 3 or even 2 years is now being promoted (Entz 2002). The aim here is to capture the cyclic benefits of forages across a greater area whilst maintaining the annual cropping areas.
Forages are generally removed in the growing season prior to the annual crop being planted. Nearly all methods of removal involve some degree of cultivation, as removal under a no till system does not result in adequate control of the stand (Mohr, 1999).

The significant agronomic benefits of including perennials into farming systems are well documented and widely considered standard practice across the NGP.

Biotillage

Biotillage is defined as tillage by soil biology. It is the opening of the soil structure by the roots of plants and the tilth of soil by soil microbes. Research into biotillage and the beneficial work that perennials do at depth in the soil has been well documented over time in the NGP. Work dating back to the early 1940s showed improved soil structure at between 10 and 60 cm after a perennial forage legume phase, where improved structure of only the top 10cm band was found after annual crops (Pavlychenko, 1942).
The sole reason that root systems of perennials are able to achieve this level of “Biotillage” over that of an annual plant is simply time. Over the period of a number of years lucerne for example can drive its roots down to 5 meters or more, creating channels, drainage lines and reducing soil

constraints down to that level. Annuals on the other hand only have a short period, normally 100 -120 days in which to build a root system and will often only grow in the top 10 -20 cm of soil. In the face of rising energy, mechanically tilling the soil down to these depths is now becoming economically questionable. This has also seen renewed interest in the Biotillage work that perennials are capable of doing.

Carbon sequestration

Carbon sequestration is the process by which plants sequester atmospheric CO2 and through the plant growth convert that to root matter which results in an increase in soil organic carbon (Baron 2004). The potential for perennial based farming systems such as lucerne to sequester carbon over and above that of annual plants is well recognized. The deeper root systems of perennial plants also allows carbon to be placed deeper into the soil profile. One of the main reasons for this in the NGP is that perennials such as lucerne and the native prairie grasses need to survive over winter in very extreme conditions and a strong root reserve is essential for survival. This could also be said of perennials grown in Australia, drought tolerance would also encourage this storage of carbon.

Carbon sequestration in cropland seeded to perennial grasses averaged 1.1 Mg C per ha per year over a five year period in a survey of land in the NGP (Gephardt et al 1994). This rate of sequestration has resulted in organic carbon percentages of between five % and eight % in some areas of the NGP.

Research is also being undertaken by Ag Canada into the potential for perennial based forage systems to become “carbon sinks” allowing producers to then sell these “credits” to carbon producing companies to off set their production. It is envisaged that the system would operate similar to the one proposed in Australia, the difference being that credits are received for Carbon that is produced under the ground and not above, allowing for producers to graze and cut forage on the land while credits are being received below ground level.

Perennials and weed management

The rapid growth of organic production in the US and Canada has resulted in many growers having to seek alternative methods to manage weeds in cropping situations. The use of perennials for these growers has become

increasingly important. Lucerne is often being used by NGP growers as the first stage to becoming organic (Entz 2004). Lucerne planted and cut for forage or grazed for a number of years to reduce the weed burden allows farmers to enter an organic farming system with very low weed levels.
In a survey of Canadian prairie growers, 83% of respondents reported fewer weeds after lucerne than in grain rotations (Entz et al. 1995).
It has also been found that even in single years forage crops can provide significant weed control benefits (Schoofs 2000).
Over 16% of arable land is sown to forage perennials (Ag Canada. 1999) This is a major factor in the low number of herbicide resistant weed populations in this area. The area that organic producers have sown to forages is generally considered to be significantly higher than that of conventional farmers, weed control being the sole reason for this.

Perennials and the environment

The impact of farming on the environment and in particular the impact of annual cropping systems on under ground water tables through the leaching of nutrients is a very serious problem in the NGP. It is widely recognized that perennials can, through their extensive root system, stop the leaching of nutrients though the soil profile. A long term study, in Saskatoon Ca. (Campbell 1994) found that a three year lucerne-brome grass perennial pasture reduced the buildup of subsoil nitrates NO3 to a level of 240 cm. The scavenging role that perennials play to extract deep – leached nitrates is becoming more important as large scale livestock production increases in the NGP (Entz 2002). Lucerne is used here to mop up nitrates that are produced from these intensive livestock operations. The environmental regulations placed on intensive livestock producers have seen an increase in the use of perennials for the recycling of nutrients and for the protection against spillage and run off of waste effluent.

Having a perennial ground cover in the NGP is also recognized as playing an increasingly important role in providing a critical habitat for many species of wildlife. Lucerne in particular is considered the beginning of the food chain, and contributes valuable habitat for hundreds of species of herbivores and animals of prey (Putnam. D. 2001).

5. Biotechnology

Investment and adoption of biotechnology in agriculture in both Canada and the US is far more advanced than in Australia. Biotechnology and genetically modified organisms are being rapidly adopted by many NGP farmers.
The government's open policy on biotechnology, especially in the US, has allowed for enormous growth in investment by the private sector.

Genetically Modified Organisms

One of the most exciting developments in technology is in the area of herbicide resistant plant genetics. The Monsanto company's patented "roundup ready" technology has been inserted into the lucerne plant. This allows for the broad spectrum knockdown herbicide glyphosate to be sprayed directly on the crop of lucerne, killing only the weeds. Roundup Ready Lucerne is currently being trialed in the US with an expected release date in 2005. This will potentially allow North American farmers to have access to a cost efficient and effective in-crop herbicide when establishing lucerne. This is currently not available to Australian growers.
Monsanto is also directing research at perennials with their Alfalfa Leader products which contain genetic resistance to potato leaf hoppers, which increases stand life and reduces yield loss.

Ecovars

Ecovar is a term used in Canada to describe an ecological variety. It is considered an intermediate step between a true native plant and a cultivar. Ecovars are the offspring of plants that have been specifically selected from a larger population for their ability to survive and reproduce in specific regions of the Canadian prairies. Ag Canada has undertaken this program with the specific aims of increasing the percentage of perennials in the annual cropping regions. Ecovar varieties are now being commercially produced by a number of seed companies across Canada. This is an excellent example of using the breeding technology of today to enhance native varieties that farmers would not normally consider growing.

6. Marketing

Access to a large domestic market for both grain and forage products is a major benefit of the NGP farming systems. The North American market has a relatively high disposable income and is both quality and environmentally aware. This is indicated by the rapid rise in organic consumption and demand for environmentally “safe” products across the region. The growth in organic consumption in the US alone is in excess of 20% per annum, with sales expected to reach USD $21.8 billion in 2005 (Moody 2004). The higher price that organics command over conventionally produced products indicates that consumers are willing to pay a price differential for a product that is perceived to be produced in an environmentally friendly way, and in a manner in which will make for a sustainable farming system.

The focus on organics has prompted a number of marketing initiatives in the NGP. The most interesting of which is Pesticide Free Production, and is the result of a joint venture between a group of farmers and the University of Manitoba. Farmers are able to certify and then market their produce as PFP if no chemical pesticides are used in that crop phase. The lack of long term restrictions on chemical use allows farmers to target specific paddocks to produce PFP crops, but to access pesticides if the situation becomes unviable and then renter the program in the following year. It is considered to be a compromise to full organic production. The major crops produced in this model are corn and sunflower seeds, both of which the consumer purchase as a relatively unprocessed product and the link between chemicals and consumers is considered high.

Although organic produce sale still represent only 3-4% of total agricultural sales (Moody, 2004), the growth rates in this area and marketing advantages have seen the Canadian Wheat Board (CWB) establish an organic grains department in 2002.

7. Government

Both the Canadian and US Governments offer a number of innovative support programs to farmers and land holders to assist in the management of the environment.
The large domestic market in the US allows government programs to have a degree of funding and financial security not seen here in Australia. U S farmers have access to the “Set a side program”. This allows landholders to attract a direct subsidy when agricultural land is taken out of production and reverted back to native grass land. This program has also had the direct benefit of creating a native grass seed industry, allowing farmers still focused on production to grow perennials for revegatition seed in an annual cropping rotation.

The Canadian Federal Government, through its agricultural department, Ag Canada, has been undertaking a number of programs to increase the level of native perennials across the prairie. These programs are practically targeted at marginal farm and range land. The “Green Cover” program aims to improve grass land management, protect water quality, reduce green house gas emissions, and enhance bio diversity and wildlife habitat (Agri-Food Canada). The main component of the program is “Land conversion”, converting environmentally sensitive land to perennial cover. Registered land owners are able to receive a direct government subsidy to cover the cost of some inputs if they agree to sow land back to perennials for a period of at least ten years. The range of species used and the number that are deep rooted and long lasting is also specified, with native species attracting the highest subsidy rate. This has the effect of preserving the biodiversity and mimics the water use of the native ecosystem, preventing any further environmental degradation.

8. Conclusions

Agronomic

The benefits of incorporating perennial forages into cropping systems include increased soil organic matter, improved soil physical properties, reduced soil erosion, suppression of weeds, disruption of plant disease cycles and lowering of under ground water tables.

Australia's very poor and fragile soils and the history of perennial cover prior to clearing indicate that these benefits could be directly translated to Australian farming systems. In particular the innovative use of perennials by organic farmers in North America to control weed seed banks can be related to Australian farmer's battle to control herbicide resistant weeds in annual cropping rotations. The introduction of a perennial or forage phase in our farming system would dramatically reduce weed numbers.

The extensive and deep rooted nature of Australia's native vegetation has been a form of Biotillage; however the continued annual cropping of land has seen a dramatic reduction in soil structure. Increases in sub soil organic matter and structure can only be achieved through the introduction of a phase farming system which includes a perennial with a root system similar to that of the native vegetation. The leaching of nutrients on Australian sandy coastal plain is another area where deep rooted perennials in phase with annual cropping would have major positive environmental impact.

Biotechnology

Investment and adoption of biotechnology in agriculture in both Canada and the US is far more advanced than Australia. Biotechnology and genetically modified organisms are being readily adopted with very little resistance from consumers as in Australia. The US and Canadian governments operate with an open policy on biotechnology which is encouraging innovation is this area.

"Roundup Ready" lucerne would be of great benefit to Australian growers. Early weed control in lucerne is considered to be a major reason for the slow adoption of lucerne by Australian farmers due to high cost of selective herbicides (W.A. Ag Dept Survey 2001).The current Western Australian Government moratorium on GMO technology is a major hindrance to grower decisions on planting perennial crops such as lucerne.

Marketing

The North American farmer's access to a large, quality conscious domestic market is a major benefit to their farming systems, allowing producers to differentiate when a commodity is produced in a sustainable manner and command a price differential for this. Models such as the Canadian Pesticide Free Production system need to be explored by Australian growers if we are to take advantage of these market differentials in our domestic market.

The range and scope of Australia's environmental issues surrounding grain production indicate that there would be significant advantage here for wheat that could claim to be sustainably produced.

Significant education has to take place in Australia's wheat export markets to highlight the environmental impact of wheat production and to explore the potential for product differentiation on an ecological basis. Some initiative needs to be taken here by exporter AWB International to seek suitable markets for this product.

Government

Both the Canadian and United States Governments offer a number of innovative support programs to farmers and land holders to assist in the management of the environment. The Green Cover project is an excellent example of how government, through the use of a subsidy on planting costs, have increased the area of perennials in the prairies.

There has been a history in the Landcare industry in Australia to avoid the funding of projects that may result in a direct economic benefit to growers. This approach in funding needs to be altered if long term economic solutions to sustainable farming are to be found. Subsidized planting costs for perennials that would be a direct substitute for an annual crop needs to be considered by the landcare industry in Western Australia.

The current lack of intensive livestock industries is also a challenge that needs to be overcome if the state is to adopt a higher use of perennial forages. Landcare Australia should be investigating the potential of funding arrangement in this area.

9. Appendix

- Dr Vern Baron 2004, Personal interview.
- Gephardt, D.l. 1994. The CRP increases soil organic Carbon. Soil and Water Conservation Dept.
- Schoofs 2000, the influence of forages on weed dynamics. Ca.J.Plant Science.
- Palychenko T. 1942. Root systems of certain forage crops in relation to management of agricultural soils. Apub1088 Ag Canada.
- Entz.M.H. 2004, Personal Communication.
- Moody.A. 2004 Personal Communication.
- Mohr 1999, Forages improve prairie cropping systems. University of Manitoba. R3T 2N2.
- Campbell.C.A. 1994 Nitrate leaching in an Udic Haploboroll. Qual.
- Putnam D. Alfalfa, wildlife and the Environment, in the 21 century.

2004 Ron Badman Churchill Trust Tour Itinerary

United States of America and Canada

26/7/2004 University of Wisconsin, Wisconsin - USA
Josh Posner – Department of Agronomy. Whole farm planning, System trials, Innovative programs to encourage sustainable farming.

27/7/2004 Green Bay region Wisconsin – USA
John Bobbe – Executive Director Ofarm. Marketing programs for organic grain products, producer marketing programs and cooperative organic sales.

28/7/2004 Cleveland, Wisconsin - USA
Karl Klessing – Manager Saxon farms. Grass feed milk, Lucerne/grass rotational grazing, marketing advantage over grain feed and input control.

28/7/2004 University of Wisconsin, Arlington Research Station – USA
Janet Hedtcke – Senior Research Specialist, agronomy. Cropping systems trials cover and intercropping, prairie control and livestock included.

29/7/2004 Janesville, Wisconsin – USA
Leo Johnson – Manager Johnson Tractor Inc. seeding, forage and harvest machinery, spearmint as a phase deep rooted annual.

30/7/2004 Michael Fields Institute, East Troy, Wisconsin – USA
Ronald Doetch – Executive Director. Conservation security program, Japanese forage demands, US subsides.
Walter Goldstein – Research Director. Lupine, clover and medic breeding, organics, using cover crops to reduce weed pressure.

2/8/2004 Chicago, Minnesota – USA
Steven Gunning – Prudential Securities, Chicago Board of Trade. Financial grain market overview and Chicago board structure.

3/8/2004 St Louis, Illinois USA
Gary Barton – Biotechnology Guest Relations Monsanto. GMO Lucerne. Roundup ready technology, disease and pest technology, consumer and government relations.

6/8/2004 Pierre, South Dakota – USA
Prof Dwayne Beck – Director, Dakota Lakes Research Farm. Ecosystem management, rotational phase farming using perennials and sustainability.

8/8/2004 South of Medora, South Dakota – USA
John Howe – Farmer. Rotation, water use in crop types and grain cleaning.

9/8/2004 Beach, North Dakota – USA
Mike Zuke – Farmer. Perennial grasses, cover crops for residue management and disease pressures on rotations.
Jon Sitka – Research Agronomist. US farm drivers, loan deficiency payments and alternative crops.

10/8/2004 Boisevain, Manitoba – Canada
Scot Day – Ag Canada Farm Consultant. Salinity issues in Ca, market links, local farm business managment and farm equipment.

19/8/2004 Winnipeg, Manitoba – Canada
John Tencha – Canadian Wheat Board. CWB structure, political and grower issues, and management of the single desk.
Barry Senft – Canadian International Grains Institute. Marketing Canadian grains to the world, monitoring of grain quality.

23/8/2004 University of Manitoba, Winnipeg - Canada
Prof Martin Entz – Director Research cropping systems. Cropping system trials, rotations using Lucerne, weed managment, organic systems and cove cropping.
Jane Froese – Assistant Prof System's agronomy. Beneficial effects of Lucerne phases, soil pathogen managment and nutrient catching with Lucerne.

24/8/2004 University of Manitoba, Winnipeg – Canada
Garry Martens - Farming system and weed trials, engineering solutions.

24/8/2004 Starbuck, Manitoba – Canada
Eric Gregory – Agronomist, Morse Brothers. Spray application technology, aerial and ground, agronomic advice structures.

25/8/2004 University of Manitoba, Winnipeg – Canada
Sharon Dawson – Research Technician. Pesticide free production, farming with fewer chemicals and forage systems farmer case studies.
Glen Way – Farmer. Rotational grazing with Lucerne, organics and Lucerne establishment
Clark Combs – Farmer. Lucerne hay marketing and production, pasture poultry using Lucerne.

26/8/2004 Winnipeg, Manitoba – Canada
Gord O'Keefe – Business development, McLeod Harvest. New harvest technologies, harvest equipment for farming systems.

27/8/2004 Indian Head Research Station, Saskatchewan - Canada
Blair McClintion – Executive Manager, Sask Soil Conservation Assoc. No till farming trials, conservation techniques and crop agronomic trials'
Guy Laford – Research Director, Ag Canada Research farm. New technologies for nutrient status, green seeker trials and plant nutrient studies.
Emerald Anderson – Sales Rep, Conserve Pac Seeding Systems. Seeding equipment, and long term no till farming trials.

30/8/2004 Regina PFRA, Saskatchewan – Canada
John Sharp – Director of Greencover Canada. Land conversion programs, land use environmental planning and using incentives to encourage sustainability.
Chris Stefner – Extension, Prairie farm Rehabilitation Administration Shelterbelt Centre. Agro forestry research and trials, and farm tree supply.

31/8/2004 Outlook, Centre for Irrigation, Saskatchewan – Canada
Garth Weiterman – Senior Agrologist, Agriculture, Food and Rural Revitalization. Salt surveying, irrigation promotion, farm diversification
Grant McLean – Irrigation Agrologist. Centre pivot research and production.

1/9/2004 Swift Current, Research Station, Saskatchewan – Canada
Alan Iwassa – Animal Nutritionist & Pasture Scientist. Native pastures, animal nutrition on lucerne and longevity of pastures.
Harold Steppuhn – Research Scientist Salinity. Salinity, ground water trials
Trevor Lennox – Forage Agrologist. Forage uptake programs and agronomy.

2/9/2004 Swift Current, PFRA, Saskatchewan – Canada
Craig Gatzke – Conservation Specialist PFRA. Perennial systems, ecovars adapting natives to suit grazing pressure.
Paul Jefferson – Forage Project Leader. Phase rotations with perennials, root systems of grasses and removal before cropping.
Chantal Hamel – Soil microbiology Scientist. Microbiology under cropping systems and over wintering.
Herb Cutforth – Climatology Scientist. Tall stubble microclimate and yields.

3/9/2004 Swift Current, Research Station, Saskatchewan – Canada
Leslie Yasual – PFRA. Whole farm environmental planning and government assistance.
Les Bohrson – Senior Agrologist. Lucerne irrigation and hay quality.
Harold Steppuhn – Salinity, geomorphology and geology in Swift Current.
Mark Stumborg – Senior Engineer. Engineering and agriculture, research directions for cropping systems.

6/9/2004 Brooks, Alberta – Canada
Duke Joy – Feed lot Manager Lakeside Beef. Largest feed lot in Canada, forage and grain supply, production issues.

7/9/2004 Brooks, Alberta – Canada
Henry Najda – Research Agrologist. Forage and turf seed production.
Shelly Woods – Microbiologist. Field salinity testing, soil production limitations and varietals selection.

9/9/2004 Lethbridge Agricultural Research Institute, Alberta – Canada
Dr Surya Acharya – Research Scientist and forage breeder. Perennial rye, anti bloat genetics, salt tolerance foe lucerne and forage directions
Dr Jill Clapperton – Soil Microbiologist. Cover crops, farming systems and soil health under long term rotations.

15/16/17/9/2004 Woodstock, Ontario – Canada
Outdoor Farm show and field days.

16/9/2004 Lacombe Agricultural Research Station, Alberta – Canada
Grant Lastiwka – Forage Network Extension. Removal of lucerne under long term rotations.
Lorne Erickson – Forage Network Economist. Economics of forage crops and long term perennial stands.

17/9/2004 Lacombe Agricultural Research Station, Alberta - Canada
Dr Vern Baron – Research Director Forage Network. Forages and sustainability, perennials and the beef industry.

20/9/2004 Neil Crawford Center, Edmonton – Canada
Peter Gamache – Team Leader, Reduced tillage Linkages. Cover, intercropping and no till research directions.

21/9/2004 University of Alberta, Edmonton – Canada
Dr Ellen Goddard – Rural Economist. Cooperative structures, marketing value added products and investment in agriculture.