2003 SCHOLARSHIP REPORT

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Topic:

LUCERNE POLLINATION USING LEAF CUTTER BEES

SUSTAINABLE AGRICULTURE WITH A BALANCED LIVING SOIL

Sponsored by:

Grains Research & Development Corporation

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EXECUTIVE SUMMARY

A Nuffield experience gave me the opportunity to investigate several key issues influencing the production and marketing of Australian lucerne seed and Biological Farming Systems in North America.

The critical issues for the lucerne seed industry are as follows:

- Low seed yields due to our competitors having access to superior pollinators;
- Leaf Cutter Bees - the climate and management factors that influence their successful propagation and pollination of crops in the Northern Hemisphere;
- Environmental impact of establishing Leaf Cutter Bees in Australia;
- Varroa Mite - their likely incursion will decimate populations of our main pollinator;
- Honey Bees;
- Genetically Modified Roundup Ready Lucerne - market access and effect on global sales.

This report addresses these issues and their impact on this unique industry.

The farming sector is facing change at an unprecedented rate in various forms such as technological advances, or environmental sustainability. Biological Farming certainly encompasses both of these and is the reason I chose to participate in a Biological Farming Study Tour hosted by Dr. Arden Anderson through Canada and USA.

The tour included a broad range of soil types, from desert sands to clay dominant loam with all the inherent nutrient, structure and disease management issues that they encompass. Climate variability is also a major influence in this system, where you are dealing with millions of microscopic living organisms. This area was well covered with the extremes of sub zero winter temperatures in Manitoba Canada, through to the blistering heat of an Arizona USA summer.

The introduction and management of microbiology through the use of green manure crops, compost and, more recently, compost tea, was well highlighted by farmers who had been utilising this system for up to twenty-five years.

Their holistic approach to sustainable, profitable farming and desire to provide a healthier, more nutrient dense food to consumers, who are only now becoming aware of the dire consequences of today's over processed food, was a lesson for us all.

Enthusiasm and an unquenchable thirst for knowledge by these farmers is clearly evident as they recognise their involvement in what can be termed 'The Biological Revolution'.

ACKNOWLEDGMENTS

For most scholars the prospect of travelling around the world for several months initially seems like mission impossible, considering all of the usual family and business commitments.

While there does need to be some adjustments and good planning to make this possible, the Nuffield Association and Directors cannot be thanked enough for all of the organisation that is involved in the six week tour. It provides scholars with the support and confidence that is necessary to achieve the most from their ten-week personal tour. All of this of course is only a small piece of the jigsaw that has to be completed for a scholarship to be made available.

Grains Research and Development Corporation (GRDC) provided my sponsorship, for which I am very thankful. The commitment to agriculture of this great organisation is reflected in the high regard, which they are held in overseas.

Most of us need that extra nudge before applying for a scholarship and I would like to thank Brendon and Robyn Smart for their part. Especially Robyn, who was able to put into perspective the far reaching benefits, as opposed to the extra responsibilities for the "deserted" wife in the short term.

The friendships created and the great times shared by the scholars that I travelled with, will always be treasured, as will the time and help provided by other past and present scholars in the quest for information on my topics. A special thanks to David McElrae and his family, in Northern Ireland.

Nevertheless, none of this would have been possible without the support of the many people that are an integral part of a modern day business, including of course my workmates who did an excellent job, as they keep reminding me!

Finally I would like to thank my wife, Karen and children, Justine, Brady, Brooke and Lexi for their wonderful support and encouragement, allowing me to pursue what can only be described as an adventure of a lifetime.

PROGRAMME - 12 JULY TO 4 OCTOBER 2003

Argentina Uruguay Chile
Mark Sowerby John Le Plastrier, Seed importers, plant breeding centre, in field trials

University of California -Fresno
Daniel Munk, water /soil adviser
Shannon Mueller, lucerne seed production

USDA Water Management Research Service- Fresno
Jim Ayars, water use, irrigation efficiency

Tanimura & Antle- Salinas CA
Carmen Ponce, Human Resources
Subsurface Drip Irrigation

Forage Genetics International- Nampa ID
Bill Knipe, plant breeding, lucerne management

International Pollinating Systems-Nampa ID
Ron Bitner, lucerne seed production, leafcutter bee pollination

Biological Farm Study Tour-Canada, USA
Dr Arden Anderson, nine state tour of fourteen commercial farm & turf operations
BF and Compost Tea principles

Simpro Ireland-N Ireland
David McElrea, green manure, compost production and utilisation

Queens University-Belfast, Ireland
Nutrient availability and management

Harper Adams University- UK
Alan Keeling, composting principles

Landview Associates- UK
Michael Harrington, biological and compost tea management in UK

The Farm Store- Scotland
Andrew Boothey, on farm store

AIM

My original aim of applying for a Nuffield Scholarship was twofold.

Firstly to find solutions to what I saw as the real threats to the lucerne seed industry in Australia. Secondly, to study the effect of increased microbiology levels on soil nutrient availability, organic carbon levels and plant health.

Having been involved in the production of irrigated lucerne seed, the constant dilemmas we faced were the shortage of honey bees for pollination, a declining water resource in quality and quantity, the constant threat of grain loss and damage due to harvesting during the autumn and the reliance and unpredictability of our main market, Argentina.

Australian History of the Leaf Cutter Bee (LC)

It is the dominant commercially managed pollinator in the lucerne seed industry in USA, with honey and alkali bees being the other two. There have been two projects to introduce LC into Australia, the Megachile Cooperative in the 1980's, and a joint venture by CSIRO Pioneer Seeds GRDC and RIRDC from 1997–2004. Both have failed, mainly due to importation restrictions, climatic factors and poor management through lack of experience. Now the importation protocol and environmental impact studies have been completed but there is still not a commercial population in Australia.

The goal of my study was research and identifies the climatic, pest, disease and management factors that need to be addressed to make LC a successful commercial pollinator for the Australian seeds industry.

Australian agriculture is embracing Biological Farming (BF) at a fascinating rate.

While many farmers lack the knowledge of the scientific interaction of soil biology, they are very aware of the limitations to plant production due to limited poor biology, inadequate organic carbon levels and low soil nutrient availability. In discussion with farmers, I found there are as many different opinions as to what is BF, as there are "snake oil salesmen" with the next wonder product. This has led to much confusion and cynicism, as farmers have found it is a developing farming system, with minimal replicated scientific comparison, against conventional chemical farming.

The second stage of my personal study included a biological study tour with Dr Arden Anderson and twenty-five Australian biological farmers, through Canada and USA.

HISTORY

The Australian Lucerne Seed Industry is based in the south-east of South Australia which produces over 90% of the 6000 annual production.

This unique region has a Mediterranean climate, is irrigated from an unconfined aquifer and has sandy loam topsoil with well-drained calcareous subsoil.

Lucerne is of immense value in the sustainable cropping systems and forage industry. It is a perennial legume that has an ever-increasing role to play in the environment, in such issues as soil salinity, soil fertility and health.

There are several critical issues facing the industry:

Lucerne Pollination

Lucerne is a perennial legume, which requires pollination and cross fertilisation to ensure adequate pod fill to be a commercially viable crop. Pollination has consistently been identified as the major limiting factor to higher, more reliable yields and improved seed quality, by leaders in the lucerne seed industry.

The European Honey Bee (HB) was successfully introduced into Australia in 1822. The gross value of production from managed HB is estimated at $50-$55 million per annum. However the gross value of pollination by HB to the agricultural economy is well in excess of $1 billion per annum.

They are the major pollinator of lucerne in Australia, however, research has shown that when used in commercial fields only 35% of flowers visited are “tripped”, resulting in seed pods. The tripping of the stamen involves the HB being hit on the head, so they will avoid this by foraging on other food sources, or approaching the flower very carefully to extract the nectar, thus resulting in no pollination. The result being seed yields less than half that of our North American counterparts.

There is a widespread shortage of HB due to apiarists exiting the industry, through shortages of labour and poor returns.

Additionally, HB around the world is under ever increasing threat by a range of parasites and diseases.

Varroa Mite, Varroa destructor, is a parasite of the HB, and they have become widespread in every country where HB are prevalent including New Zealand and have now been found in the Australian Islands to our north. From overseas experience, we know that an incursion of Varroa Mite will eliminate all unmanaged colonies, ferals, and lead to a reduction of between 30–50 % of managed colonies. With chemical control of this parasite proving to be extremely limited and with only 1% of inward shipping containers entering the country being inspected for feral colonies, an incursion is a matter of when, not if.

Environmental Issues

Underground Aquifer

The majority of the seed production is by flood and centre pivot irrigation, from an unconfined aquifer, during the months of December through to February.

This, however, is a declining resource with salinity levels increasing by 60ppm annually in some areas, which has instigated producer-imposed restrictions. The static water level is also dropping, causing a reduction of quantities available and landholders having to deepen, or in some instances renew bores for irrigation or stock water.

Pesticide Use

The farming sector is coming under increasing pressure to reduce applications and toxicity levels of pesticide usage. A shorter pollination and ripening period would achieve this.

Time of Harvest

Irrigated lucerne seed has a crop season of 16-17 weeks, with fields closed for seed production over a four-week period from mid November to mid December, resulting in harvest through April. This does make it susceptible to grain loss and quality downgrading due to weather damage.

A shorter crop season and a percentage of earlier crop closure would provide better utilisation of spring rainfall and lower evapor-transpiration rates resulting in a reduction in irrigation applications.

For this to be achievable, either higher densities of HB are required, or other types of pollinators.

MY STUDY

Argentina

My tour commenced in Argentina two years after their credit crisis, which devalued their dollar down to one third of its previous level.

Agriculture is leading the way in the strong economic recovery with a growing confidence and a desire for technological advances. Highly fertile soils to 50m and one metre of annual rainfall also play a large part.

Argentina is the largest importer of lucerne seed, (40-50% of annual production) which has always made it of vital importance to the Australian seed industry.

We travelled for a week, meeting with the key importers. It soon became evident that the recent economic upheaval and high levels of corruption, have taken their toll, meaning that the relationship between importers and exporters is paramount and needs to be nurtured, with constant communication and market information, to ensure a high level of trust. As described to me by a long time client, their history dictates that in business, they will deal with family first, friends second and everyone else sometime later!

The market is divided into three segments

Winter dormant, 2-4, blended varieties from Canada, Europe, inexpensive

Mid activity, 5-8, Australian varieties in mid price bracket

Highly activity 9-10, American varieties which command a premium.

The Australian product is perceived to be of lesser quality than the American, due to a combination of outdated poorly presented packaging, at times lower germination specification lines, which give the impression that our product is sub-standard. Unreliable arrival dates due to shipping and quarantine inspection delays, that means that seed harvested in April will not arrive in time for a September seeding.

This causes large imbalances all the way through the supply chain, culminating in cash flow delays, which is frustrating the whole industry.

If this could be achieved, it would give us an edge over the American crop, which is only harvested in August.

With continual breeding and releases of new varieties offering more production and persistence, we should be well placed to take advantage of this expanding market.

Of greatest concern is the wide acceptance of GM corn and soybeans in the farming sector that will facilitate Roundup Ready Lucerne, which will be available in America in 2005, to replace conventional varieties. If this does eventuate the moratoriums in Australia on GM will lock us out of this lucrative market.

Gentos Research Centre, Buenos Aires, Argentina
L-R Juan José Amadeo - Gentos, John Le Plastrier, Mark Sowerby - Seedmark

Lucerne seed repackaged into gusseted paper bags with superior printing, packaging and stackability

White Australian poly bags with poor quality printing and appearance.

PACIFIC NORTH WEST LUCERNE SEED PRODUCTION & POLLINATION

Since the large oversupply of lucerne seed, (or alfalfa as it is known in North and South America), which was due to a very large crop in California in 1999 and the credit crisis in Argentina, the majority of the American crop is produced in the Pacific North West, which comprises Idaho, Washington and Oregon.

The Nampa Valley in Idaho is a fertile region that produces 110 different crops with 50 of these for seed. It produces approximately 8000tn of predominately winter dormant lucerne seed with snowmelt water through gravity fed channels to furrow irrigation.

Lucerne is under increasing pressure to maintain area against high return crops like vegetables, grape and stone fruits. Urban development into rural living blocks or housing estates, is also ever encroaching in this picturesque region. Coupled with this are very high costs of production (at least treble that of Australia) for pesticides, herbicide and irrigation. It is quite common to spray eight times for lygus bug in a season, which is creating chemical resistance and environmental issues.

The preferred use for irrigation is in higher gross margin crops for maximum return for the resource. Seed yields vary from 1200-1600kg ha, with over 2000kg having been achieved. This is largely due to the pollination of LC bees, as alkali and HB are not used in this region

ROLE OF LEAF CUTTER (LC) BEE IN IDAHO

The LC was discovered in western Idaho and eastern Oregon in the 1950's. It has since been developed into a major pollinator of lucerne by addressing the issues of climate for propagation and pollination, in crop chemical use and in parasite and disease management.

They are dormant over autumn winter and spring then incubated and released upon emergence into the field over a two-week period. This process commences at 40% onset of flower. Large shelters, domiciles, are placed throughout the field. These have a series of nesting boards in place which are commonly styrofoam blocks which have pre-drilled holes 80mm long and 5mm in diameter. Upon release, the females, which comprise approximately one third of total numbers, are mated. They then proceed with cell formation. This is achieved by cutting leaf that is placed as a lining inside the holes, then pollen and nectar is collected and formed into a pollen ball onto which an egg is then laid. With ideal conditions, this occurs daily and the female has the potential to lay 30 eggs during her life cycle.

LC, which are purchased by the gallon, which is equal to 10,000 bees are used at the rate of 80-100000/ha.

The fields generally have an insecticide applied three days prior to introduction. The rapid pollination of the crop eliminates the need for further insecticide applications and ensures a short flowering period and even pod set. They are extremely efficient and have been recorded to pollinate 90% of flowers visited, as opposed to HB at 35%.

At the end of the pollination period, the nesting boards are removed from the field and a mechanical puncher is used to remove the cells and they are placed into a controlled temperature room, where they are stored until incubation the following summer.

Some seed producers choose to have the necessary infrastructure and skills, to store, incubate and manage their own bees.

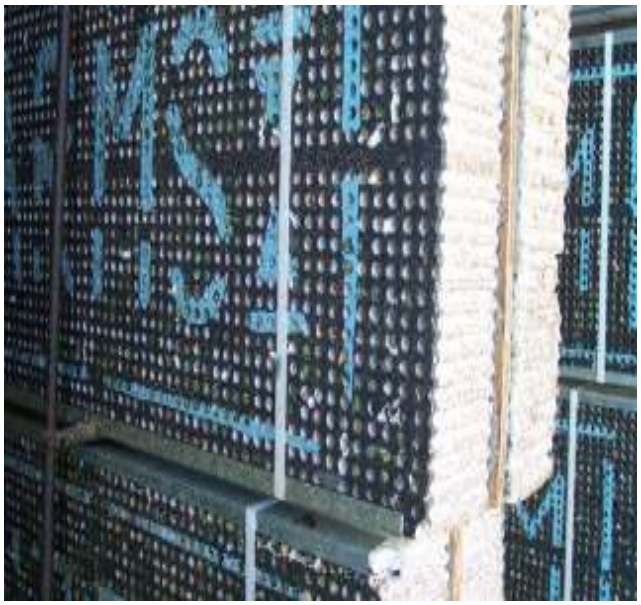
While for others, there are two options:

(1) Employ the services of a bee provider to obtain LC from people who specialise in their propagation. Canada is the main supplier, due to more favourable climatic conditions and lower risk of pest and disease. The cost varies between US$20-100/10,000 bees, dependent on supply and demand.

(2) Pollination consultants also supply bees, or can be used as a contract service to provide bees, shelters and management. The cost of this can be on a hectare basis, or a percentage of the crop.

José Avias, Forage Genetics Int. with lucerne exhibiting excellent growth and pod formation.

Leaf – cutter Bee nesting blocks



Dr Denis Anderson CSIRO Canberra and Ron Bitner Int. Pollination Services with newly hatched L-C-B

An incubator used in CSIRO Black Mountain quarantine facility.

CALIFORNIA SEED PRODUCTION AND POLLINATION

Californian seed production has declined rapidly since the high of 23,000tn in 1999. The main influences have been lower global seed prices and an ever-decreasing decline in water allocation in the seed producing areas. This has lead to higher demands and costs of water, up to US$200/megalitre, resulting in smaller economic returns and planted area.

They have very dry hot summers for seed production and use LC in conjunction with HB for their pollination. These are obtained through bee providers, or pollination consultants from Canada, as the climate is not conducive for productive cell multiplication.

VARROA MITE

Varroa mites have become a major pest of the HB since their introduction into Florida in 1980's. Varroa mites are external honeybee parasites that attack both the adults and the brood. They suck the blood from both the adults and the developing brood, weakening and shortening the life span of the ones on which they feed. Untreated infestations of varroa mites that are allowed to increase will kill honeybee colonies.

It has led to a major decline in HB populations in California recently which has created a severe shortage. In 2005, pollination costs for almonds have increased from US$30-135. With limited control methods, the HB industry is in a crisis situation.

ATTRIBUTES OF (LC) FOR LUCERNE SEED POLLINATION

They are an extremely efficient pollinator of lucerne. The females are all gatherers of pollen, which is necessary for the production of cells, so they have to trip flowers to gather the pollen.

They are not affected by Varroa Mite and can be used in conjunction with HB.

Lucerne is their preferred crop, even if other sources of pollen and nectar are available.

They will only travel short distances, so field placement of their nests ensures they will forage where they are needed.

Their aggressive foraging increases pollination, even in harder to trip varieties

Faster pollination leads to more even ripening, a shorter crop season, insecticide and water use reductions and less weather damage to seed.

They have a broader range of working temperature, giving more flexibility to crop growth season. Earlier closure and harvest gives more use of spring rainfall and better seed quality.

LC hatched and ready for distribution to the field

THE BIOLOGICAL FARMING (BF) REVOLUTION

In Australia, the first significant wave of BF was in the late '90's. There were a brave few who experimented and started to implement biological practices, usually to be ridiculed and be labeled as followers of that "Mumbo Jumbo".

However, some five years on, there are enough success stories, as well as some disappointments, to ensure a producer driven demand for further information. This I believe is the second wave and the momentum that is being created, justifies it being given the "Revolution" title. Being a minimum tillage farmer, I had always been concerned with stubble management, soil aeration and chemical effects on soil health. After using some biological products with limited success, I was still having problems with breaking away from the conventional chemical farming mindset. So to understand this "new" farming system, I chose to participate in a BF tour.

Dr Arden Anderson, who is an authority in biological agriculture and is an agricultural consultant to farmers, farm consultants and product companies around the world, hosted this. He was raised in Michigan USA and specialises in nutritional management of soils, crops and animals, in a productive, profitable economically sustainable way.

The aim of the tour was to visit fourteen BF in nine states in Canada & USA, with varying soil, climatic and environmental conditions and restrictions, to demonstrate the effects of increasing Soil Biota and the use of Compost Tea & Green Manure in commercial operations. Visit farmers who had been practising BF from 5-26 years and particularly the changes that can be achieved in a short time frame

SOIL BIOTA (SB)

A soil with good biota levels will have 600 million bacteria and fungi containing 25000 different species per gram.

The four main groups which are:

Microflora e.g. bacteria fungi

Microfauna e.g. protozoa nematodes

Mesofauna e.g. mites collembola

Macrofauna e.g. earthworms dung beetles

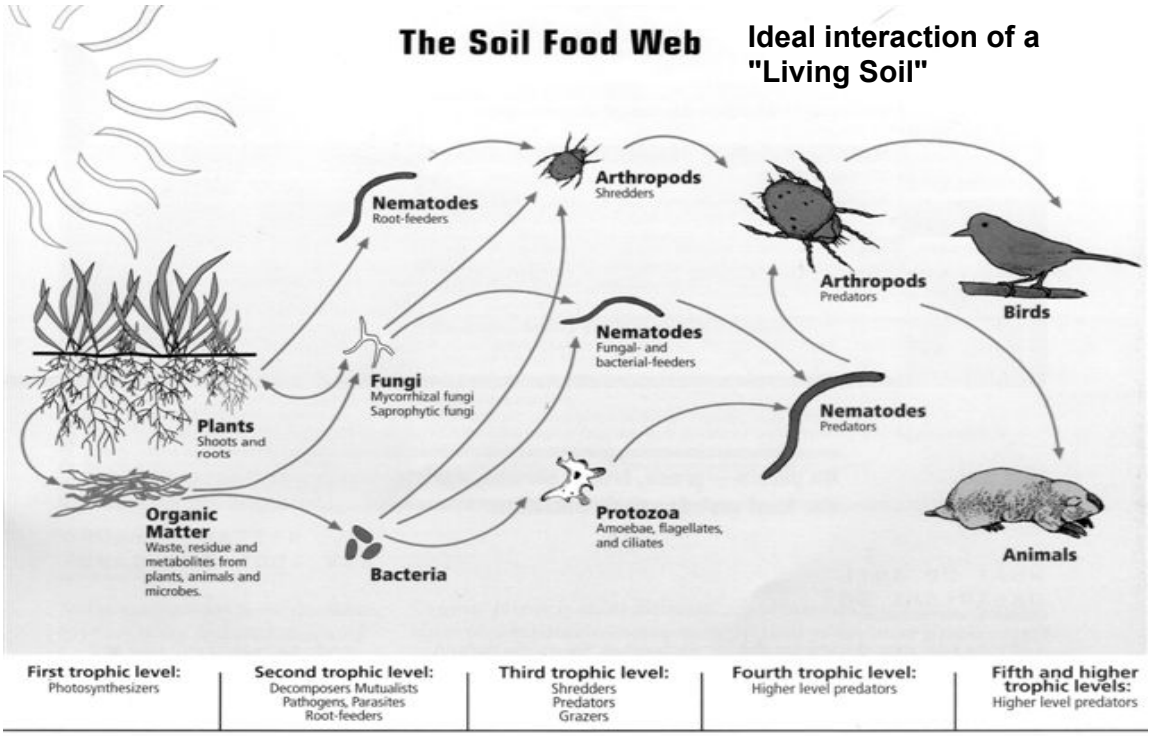
The combination of these aid in:

organic matter decomposition and redistribution

nutrient cycling and uptake

moisture retention

soil aeration and drainage



COMPOST TEA (CT)

Water extract from compost, high in bacteria and fungi.

Applied to the soil or plant for:

Nutrient uptake

Insect, disease prevention and control

Compost – Tea brewing tank

A compost – Tea immersion filter

GREEN MANURE (GM)

A crop that has a broad range of plant species and varieties that are suited to the environment, then to be turned into the soil when mature but still green, e.g. flowering.

Grown to:

Provide a food source for SB

Improve soil structure and health

Increase organic carbon

In Field Experience

Gerald & Verna Wiebe, Manitoba, Canada

They were the most northern visited. They had been Biologically Farming cereals and pulses for 6 years with dramatic results.

They had a black sticky clay soil, with 120 frost-free days and a severe winter with temperatures down to –40 and up to 2m of snow.

A green manure was commonly used in starting to build the SB levels with CT then being used to provide crop nutrients and a food source for SB.

Post harvest, the crop residue was incorporated with a CT spray, to ensure decomposition of organic matter. The soil structure was friable & aerobic to a depth of 18cm, increasing by 3cm per year, in stark contrast to a field alongside which had the same crop grown under conventional chemical farming, but had extremely compacted soil.

Gerald Wiebe, Canada, demonstrating results of Biological Farming System to soil structure and plant health.

Bill, Jason Kimm Montana USA

The Kimms farm 8000ha of G1 & G2 seed potatoes, grain & lucerne. Five years ago, they started a transition phase to BF. Their entire farm is now managed biologically, as well as operating a CT brewing commercial business & a compost operation. One of the main drivers for change, was the realisation that frequent & high application rates of chemical based nitrogenous fertilisers was leading to an imbalance in soil & plant nutrient levels. This combined with high plant nitrate levels, was leading to a high incidence of insect attack & plant fungal diseases.

CT was trialled successfully which led to the replacement of eight regular fungicide applications with eight of CT for half the cost and to significant reductions in plant diseases and insect infestations in potatoes.

Compact Turning Machine

Rows of composted straw and cow manure

Jeff Schmidt, Pasco Washington State

Farming 120ha melons, capsicums, cucumbers, pumpkins, also pulse, cereal cropping and various pastures for registered cattle enterprise.

The change to BF has increased organic carbon levels from 0.8%-2.4% and provided Jeff with improved vegetable yields & quality e.g. pumpkins 30- 100tn/ha.

The retailers and restaurants he supplies, have identified his produce as having improved shelf life, more flavor and better cooking qualities. As a result, they are requesting greater quantities, at a price premium, in what is generally believed to be an oversupplied market.

Leonetti Cellar, Walla Walla Valley, Washington State

Established in 1974 and produced their first wines in 1978. Producing 6000 cases per year, prices of US $2000 per case. In recent years, BF has been used to control fungal diseases, replacing fungicides, resulting in better grape quality and long term sustainability of this icon winery.

CONCLUSION and RECOMMENDATION

Lucerne seed production and pollination

Lucerne seed production in North America is under increasing pressure to maintain area. This is due to increases in cost of production from water, pesticides and pollination. Land development and alternative crops are also reducing area availability.

This will create an opportunity for the Australian lucerne seed industry to expand production and be recognised as a reliable supplier of a high quality product.

For this to be achieved, there are several issues that need to be addressed:

Argentina

The continual development and nurturing of this market is of utmost importance to our lucerne seed industry.

Poor packaging, labelling and presentation of seed, together with insufficient product marketing, has lead to the perception of an inferior product and therefore to discounting.

Earlier more reliable arrival of seed. There have been numerous occasions where product has arrived late, due to quarantine and exporting delays. This in turn has meant seed carryover and a perception of unreliability.

Genetically Modified Roundup Ready Lucerne - when regulatory approval in Argentina is granted, uptake will be swift, culminating in a severe reduction in the importation of conventional varieties.

Independent replicated assessment of the environmental, biological and management issues relating to GM lucerne needs to be undertaken.

Pollination

Where LC bees are used, seed yields are in excess of double the Australian yields. They also provide significant environmental advantages by reducing pesticide, water use and crop growing season.

Due to the HB being our primary pollinator, low Australian lucerne seed yields are having a major impact on the competitiveness of the Australian lucerne seed industry in a global market.

Varroa Mite have decimated HB numbers in California causing extreme shortages and inadequate pollination of almonds and lucerne. Their likely incursion in Australia will remove all feral colonies and dramatically reduce the numbers available for pollination. The viability of the lucerne seed industry will be further eroded.

Previous importation of LC has enabled an extensive Environmental Impact Study to be completed and the Phyto-Sanitary protocol to be implemented to allow fur further introductions. A comprehensive study of climate required for propagation, to identify an equivalent region in Australia, is needed.

All previous funding and research has been towards the importation and incubation of this insect and after many difficulties, mainly caused by human intervention, this process is now reliable and repeatable.

There is a real need now to take this project to the next stage.

This will require a business plan to be formulated for a 5-10 year period and the emphasis on propagation location, in field management of Australia native pests and diseases and the formation of a pollination service once a population has been established. The future success of a LC bee importation project will require the identification of key funders and stakeholders, the participation of these from the outset so that a sense of ownership of the programme is developed, and a long term commitment to the project.

INDUSTRY DISUNITY

At present Australian lucerne seed producers are divided into groups dependent on their seed marketer or agronomist, with very little transfer of information between groups. They do not have a grower body with elected representation, to address local, national and global issues, some of which have been identified.

For the future viability and security of this industry, the formation of a lucerne grower body, with linkages to the seed industry at a national level, is imperative.

BIOLOGICAL FARMING

The biological farmers we visited had a good understanding of and were addressing the critical issues of:

Soil Nutrition - test to determine nutrient status, establish factors inhibiting plant growth and add nutrients to balance or at least provide partial available levels for increased plant health.

Soil Life - recognise that soil should have high levels of soil biota and consider the positive and negative effects of cultural practices and inputs.

Nutrients - apply nutrients that are non-harmful and remain available to soil life and plants.

Available Food Source - optimise aeration, moisture and organic matter near soil surface to increase micro biology.

Green Manure - the use of a green manure crop in the rotation is an excellent way of increasing soil biota, returning lower nutrients to the surface, improving soil structure and providing a break crop for weeds and disease.

Crop Rotation - use crop rotation to lessen insect and weed pressure, resulting in fewer chemical applications.

Compost Tea - apply compost tea to prevent and control insect and disease outbreaks.

Chemical Use - aim to eliminate fungicide applications, reduce insecticide and herbicide rates and use. Minimise effects by adding buffering agents, eg fulvic acid and a food source e.g. molasses

Environment - always look to lessen the impact on environment and natural resources. Minimise pollution to air, waterways and soil.

Given the wide variation of climates and soil types biological management was still resulting in:

- Substantial improvements to soil structure and organic carbon increases of 20-30% pa
- Better balanced soil, with increased nutrient levels
- Increases of soil biota populations
- Improved plant health
- Decreased insect and disease pressure
- Less crop damage due to environmental impacts e.g. droughts and frosts
- Crop yield and quality improvements
- Greater profitability through lower costs and increased yields
- More balanced and higher levels of nutrients in produce, resulting in market driven demand and price premiums

SUMMARY

BF is a systems approach that combines the best of chemistry, biology and microbiology with sustainable farm management practices. It identifies and solves weed, disease and insect pest problems at their cause, rather than use chemicals to mask the symptom. It aims to optimise yield, quality, food nutrition and profit, whilst addressing environmental conditions,

Australian agriculture is renowned for its efficiency in today's global market. However, there is a wonderful opportunity, due to our climate, relatively low levels of farming restrictions and willingness to embrace new technology, to lead the world in the production of food that is more nutrient dense and healthier. The best way of achieving this is through a sustainable biological farming system. To my knowledge there has not been a multi replicated, independently assessed comparison, between conventional chemical and biological farming systems. There is an urgent need for this to be undertaken, to give our farmers the scientific data to be able to assess the most relevant products and management techniques, to achieve this in their business

REFERENCES

Bitner R Peterson S IPS 1998
Introducing the Alfalfa Leaf Cutter Bee into Australia

Anderson D CSIRO 2004
Quarantine risks associated with Leaf Cutter Bee importation to Australia
Varroa Mite

Morthorpe K Jones W 1998
Honey Bee pollination of pasture legume crops in Australia

De Barro J 2000
Churchill Fellowship

Ingham E 2003
Soil Food Web

Gupta V Roget D CSIRO 2004
Understanding life in the soil

Lawrie and Co 2004
Soils Alive