THE WINSTON CHURCHILL MEMORIAL TRUST

CHURCHILL FELLOWSHIP 2009

BUILDING LARGE SCALE POLLINATION AND PREPAREDNESS TO MANAGE BEE DISEASE AND VARROA MITE

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Introduction

Insect pollination is an ecosystem service with high economic value that is thought to be mainly provided by bees. Both feral bees and managed honeybees populations are under threat across the world as a result of several factors such as changes in agricultural practices, urbanization, and spread of pathogens.

The resultant habitat loss and reduced nutritional base has led to the extinction of many native bees and threatened the strength of managed honeybee colonies. Chronic exposure to insecticides, even when they are appropriately used, may affect the foraging behaviour of honeybees, which in turn weakens a colony and makes it more susceptible to disease.

Honeybees suffer from parasites like the *Varroa Mite*, and from several viral and bacterial pathogens. In the presence of Varroa Mite, many of the otherwise benign viruses become virulent, resulting in devastating losses to managed hive populations. In the USA, these losses are referred to as Colony Collapse Disorder (CCD) although similar losses to managed populations in other parts of the world are yet to be recognised under this name. Similar declines in bee populations have been recorded previously throughout history, so to what extent the current reduction in bee populations worldwide is due to pesticide use and habitat changes is unknown.

Australian is currently free of *Varroa Mite* and *Colony Collapse Disorder*. *Varroa mite* is easily spread. Despite Australian quarantine measures in place to keep pests and diseases from our shores, the arrival of Varroa mite is regarded as inevitable. In 2000, *Varroa mite* was identified in New Zealand and in New Guinea in 2000. Despite best efforts to halt the spread in New Zealand, the mite spread quickly.

Climate changes represent future threats that will probably impact native, feral and managed bee populations as well as apicultural practices. Coordinated actions are needed to prevent the global loss of large pollinator populations.

In Australia, there is an urgent need to improve awareness of the role of pollinating species across all crop types. While the importance of pollination is recognised in some horticultural crops, the assistance feral bee populations provide to many broad-acre agricultural crops is not. Recent research has identified yield responses to saturation pollination in field beans (*Vicia faba*) of around 50%. Smaller but significant responses were observed in other pulse crops. Further research on the effects of pollinators on a range of field crops is essential. A campaign promoting the importance of pollination to food security in Australia is required. Food producer awareness of the role pollination plays in production and quality is low. In addition, the threat of *Varroa Mite* incursion in Australia is high. The impact a *Varroa Mite* incursion will have on production systems in Australia is significant.

There is an urgent need to prepare for the arrival of *Varroa Mite* and to identify alternative pollinating species that exist in our environment. An examination of habitat that will enhance the existence of both native and feral populations of pollinating species is required. Together, policy makers need to link with the scientific, agricultural, apicultural and ecological communities to continue to develop and enhance programs that will ensure continued and improved pollination services to agricultural and ecosystems across Australia.

Acknowledgements

I wish to gratefully acknowledge The Churchill Fellows Association of South Australia and the Winston Churchill Memorial Trust for funding a remarkable tour of California, Europe and United Kingdom. I am also very grateful to the many famers, advisers, researchers, Syngenta and Bayer staff who gave me an insight into pollination, bee health and integrated pest management practices. Thanks also to my wife Jeanette who travelled with me for the entire tour. In addition thanks to Danny Le Feuvre (Australian Bee Services) and Ben Hooper (Apiarist and Nuffield Scholar) who joined us on the USA leg of the tour and to Michael, Sue and Connie Richards who joined us on most of the UK leg. Sharing ideas and discoveries with like minded people along the way enhanced the learning and experience.

Executive Summary

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Fellowship Objective

To investigate profitable large scale pollination services which have developed since *Varroa Mite* incursion elsewhere in the world. To examine the logistics and systems that have developed to pollinate horticulture and broadacre crops and study hive management techniques including; methods of over wintering hives, disease management, integrated pest management and breeding programs for *Varroa Mite* resistance.

Fellowship highlights

In the USA, Europe and UK, the bumblebee and other pollinating insects play an important role in buffering the effects of Varroa mite impact on feral bee populations. As mainland Australia does not have bumblebee species, the impact on crop production of the arrival of *Varroa mite* may well be much greater than experienced elsewhere in the world. Identification of the range, populations and impact on production of effective pollinating species that exist in native vegetation areas in our agricultural regions is essential and programs to support these activities are required. Operation Bumblebee and Operation Pollinator programs highlight the impact of minor modifications to floral resources which have impacted enormously on populations of pollinating insects. The existence of Government environmental support systems funding direct payments to land owners for enhancement of floral resources has assisted in this change. Such schemes do not exist in Australia. Land owners will need to see the productivity benefit from such programs for adoption to occur in Australia. Food security, food safety issues and the benefits of pollination have been highlighted to the general community in these programs.

Varroa mite was previously seen as a management issue for apiarists to contend with and did not have a large impact on concerns about food security in the USA. The more recent and dramatic effects of Colony Collapse Disorder has raised the awareness of the importance of pollination on food production.

Discussions with industry in the USA highlighted the importance of adequate preparation for the arrival of *Varroa mite*. Quarantine efforts slowed but did not restrict the spread of mite once identified. Apiarist training in the identification and management of *Varroa mite* is essential and is likely to be best provided by purchasing expertise from the USA when it arrives. Registration of a full of products for use for control of *Varroa mite* is also required.

Programs to breed for resistance to *Varroa mite* have had limited success throughout the world. Once *Varroa mite* is identified, it takes around 3-4 years for the decline of feral populations of honeybees to be noticed. Feral bee populations recovered to some extent after 8 years in the USA.

Dissemination/ Implementation

Since returning from the Fellowship I have met with Syngenta, Marketing Head Australasia to discuss development of Australian pilot of Operation Pollinator program. Syngenta have committed $15,000 to support Mike Edwards to travel from UK to Australia in September to conduct field studies and meet with key ecologists and farmer groups. Several of the state NRM Boards have also committed funding to this project.

Meetings have occurred with Dept of Agriculture, Fisheries and Forestry's representatives at Kadina and Crystal Brook to discuss support and development of "Operation Pollinator" program scoping study.

Future meetings where discussion is planned for support of similar programs will occur with State Minister for Environment and Conservation, Hon Paul Caica MP on July 21 and with Shadow Minister for Agriculture, Food and Fisheries, Mr Adrian Pederick MP, and member for Wakefield Mr. Steven Griffith MP with the Yorke Peninsula Alkaline Soils Group on Wed 7th July.

In June I addressed the South Australian Apiarists Association. An article "Beware the Varroa Mite" was published in the Stock Journal on June 10, 2010.

A meeting with Pestat's Managing Director, Dr. David Dall and Executive Officer, Chris Buller is planned for the 16th July to discuss grains industry involvement in a Rural Industries and Development Corporation funded scoping study for a proposed Pollination and Honeybee Research CRC.

Program

California
12 – 22nd March

University of California, Davis
Dr. Eric Mussen - Extension Apiculturalist
Dr. Neal Williams - Pollination Ecologist
Dr. Sue Cobey – Bee Breeder and Geneticist

Grass Valley
Randy Oliver - Apiarist and bee researcher

Fresno
Dr. Shannon Mueller – Extension Farm Advisor

Bakersfield
Bee Broker; Joe Trayner,
Apiarists; Joe Romance, Brett Adee, Jim Rosenburg,
Almond Grower- Richard Enns

Europe
23rd March – 4th April

Syngenta, Basel and Stein
Eric Guicherit – Global Technical Manager – Fungicides
Martine Arslan-Bir – Global Product Manager
Filipe Guimaraes – Global Product manager – Insecticides
Mark Bidwell – Global Business Manager
Visala James – Market Foresight and Business Planning Manager
Dr. Stephen Hole – Head of Global Field information Systems
Dr. Franz Brandl – Head Global Seed Care Institute
Martin Urban – Global Product registration Manager – Fungicides and Insecticides
Stephen Skillman – Global Technical Manager – Insecticides
Dr. Lisa Navarro – Issue Management
Suhendro – Global Product manager – Fungicides
Derek Cornes – Technical Rand D Leader – Herbicides

Bee Institute, Oberersal; Professor Dr. Bernd Grunewald

Bayer, Monheim,
Dr Dirk Ebbinghaus – Head of Experimental Station – Hofchen
Dr. Christian Maus – Ecotoxicologist - Monheim
Dr. Ralf Nauen – Senior Scientist – Product and project support – Insect Resistance Management

UK
4th – 19th April

Carolyn Cox – Agronomy Manager- Marshalls
Marak Nowakowski - Wild life Farm Co (Operation Bumblebee)
Mike Edwards –Entomologist (Operation bumblebee)
Professor Francis Ratnieks- University of Sussex – Bee biologist
Norman Carreck – University of Sussex – Bee researcher
Dr.Anthony Biddle – Technical Director- Processors and Growers Research Organisation-
Roger Sylvester Bradley- Leader -ADAS Research Center:
John Garstain, ADAS Research Center:
Tom Pope, ADAS Research Center:
Sarah Cook, ADAS Research Center:
Mike Groomer, ADAS Research Center:
Paul Miller, The Arable Group
Jim Orsen, Consultant;
Dr. Judith Pell Insect Pathologist, Rothamsted Research
John Bloomer – Global Head Cereals/Head UK Seeds

Fellowship Findings

General

- The majority of beekeepers around the world are hobbyists.

- 84% of all crop species for human consumption in Europe depends directly on insect pollination – largely provided by feral and managed hive populations.

- The market for colony rental for agricultural production systems is well developed in the US and Europe. Supply of these managed colonies is under pressure worldwide due to decreased diversity, disease and pesticides.

- 11.5 million hives in the EU region in 2005 but rapidly declining. Similar scenarios occurring globally. – eg Germany – 180 000 beekeepers managed 2.1 million colonies in 1945. Now 81000 beekeepers manage 620000 colonies.
  In the United States there are 2.4 million colonies, down from 5.9 million in 1947.
  UK have 250,000 colonies with only 6 full time professional beekeepers.
  A further 10% of beekeepers have left industry in the USA since development of CCD.

- The average age of beekeepers in USA is over 50 and in Europe the average age is over 60, with the majority being hobbyists.

- Despite steady decline of bees, pollination dependent crop yields is continually increasing at a rate of 1.5% per annum. This is due to other technology developments and needs to increase to 4% per annum to provide food growth for predicted populations in the future.

- Bombus species (Bumblebee) plays an important role in pollination worldwide. It is one of the major alternative pollinating species to Apis mellifera in the USA and Europe. Australia does not have any of the bumblebee species except in Tasmania. Bumblebee populations reduced the impact on pollination from *Varroa Mit*e causing losses to Apis mellifera populations.

The impact of Varroa Mite and Colony Collapse Disorder (CCD)

Varroa Mite

- *Varroa Mite* was first identified in the USA in 1984. Numbers built quickly. By 1994, feral populations of Apis mellifera close to extinction. A return of some feral bees occurred 6 -8 years later. The timeframe for recovery will depend on the genetic diversity within a region. Feral numbers still low.

- The feral bee is not recognized as contributing to pollination of agricultural crops.

- Wild Bombus species (Bumblebee) is making a significant contribution to general pollination.

- *Varroa Mite* females suck hemolymph of pupal and adult bees and act as vectors for virus infections. The development and reproduction of the mite takes place within the capped brood, escaping the attention of adult nurse bees.

- *Varroa Mite* can be controlled with chemicals like formic acid, oxalic acid, pyrethroids, (coumaphos)

- When associated with normally benign viral and bacterial pathogens, *Varroa Mite* can cause these pathogens to become virulent causing significant bee mortality. Approximately18 viruses reported to threaten well being of bee colonies when in association with *Varroa Mite.*

- *Varroa Mite* is hard to detect in low numbers.

- Once *Varroa Mite* was found in the USA it was not stopped through isolation. Quarantine restrictions penalized apiarists that identified the problem but had spread much further before detection.

- *Varroa Mite* arrival in the USA in the 1980's did not improve awareness of pollination importance. It was regarded as a management issue rather than a threat to food security. CCD raised awareness of pollination importance with catastrophic hive losses experienced by large apiarists.

- Breeding for hygienic traits in the hive is the priority worldwide. Hive hygiene is thought to be the dominant factor in maintaining colony health in the presence of *Varroa Mite*.

- Artificial Insemination techniques have been developed in the US to allow faster and more controlled transfer of genetic traits. There is difficulty in selection of suitable genetic material – need to take a molecular approach and develop genetic markers to identify traits that can fast track the process.

- Complexity with viral disease makes the selection processes for *Varroa Mite* much more difficult.

- Effective breeding for resistance under current breeding techniques is difficult.

- Some breeders suggest we use the genetic material we have in Australia. (Mapping of genetic material has occurred in Australia) Others suggested bring resistant material into Australia – however is doing so we may be bringing in other viral diseases that we don't currently have. There is disagreement about the appropriate way to manage this; explore the material we have first and the viral diseases we already have, support the facilities that would enable the identification of the breeding traits we require.

- Resistance to miticides; there are a range of treatments available, some more effective than others. Mites have developed resistance to miticides quickly often due to poor application techniques and continued use of the same product.

Colony Collapse Disorder (CCD)

- CCD is linked with the viral infections. CCD causes the worker bees to leave the hive and die, leaving queen and small amount of brood. There are many suggested reasons for CCD, many of which have been now discounted; the most likely and commonly agreed cause is a link with viral diseases introduced by *Varroa mite*. Although the list of viral diseases in narrowing there is no clear indication of which virus in combination with *Varroa Mite* causes CCD.

- CCD symptoms have been noticed around the world previously – first noticed in 1869, decline in bee populations recorded due to unexplained cause, 1963-1965 there was a period of rapid decline of colony strength and disappearance of bees. CCD as known today was recognized in the USA in 2005.

- Californian beekeepers are claiming that Acute Israeli Paralysis Virus (AIPV) has arrived with bees imported from Australia. This virus is thought to be believed to be the major viral link with *Varroa mite* causing CCD. Suggestions that imports of Australian bees should cease.

- Some small beekeepers use biological methods to control *Varroa Mite.* (eg Formic acid) Small apiarists are coping with *Varroa Mite* and CCD as can manage treatments and inspect hives regularly.

The business of pollination

- 1.2 mill hives brought in to California from across the US on the 15th Feb for 1 month to pollinate almonds. This is one half of the current total number of hives in the US.(2.4mill hives 2009)

- Almond acreage has increased from 174000ha in 1996 to 283000ha in 2009. There are 323000ha of almonds expected in California by 2012 requiring 2 mill hives for pollination.

- Honey from almond crop less palatable – poor market demand.

- Demand for pollination in other crops such as plums and to a lesser extent, cherries, apples, and avocadoes compete with the almond pollination period.

- Professional beekeeping has developed in US as a result of the almond industries need for colonies to pollinate the 283000ha of almonds.

- The cost of pollination has increased since 2005 from around $50 hive in 2002 to $180/hive in 2010. This price rise largely coincides with the development of CCD. Beekeepers and almond growers recognize the risk of bringing bees into almonds due to disease and this has driven up the price. This has created a profitable enterprise for beekeepers. Despite CCD influencing pollination costs in almonds, the price obtained for pollination of other crops such as watermelon, squash, and blueberrys is still relatively cheap at approx $40/hive. This has created some concern from almond producers that they are “subsidizing” pollination costs for other crop types.

- Wages in California are cheap; a large Mexican labour force is available and paid low wages of around $10-12/hr.

- Profitability of almonds very good – Costs approx $2400/ac (including pollination cost of approx $350-400/ac) with yields approx 2000-3500lb/ac (depending on age and management) with an almond price of $1.50-$2.00/lb. Gross return of $3- 6000/ac.

- Despite low % of industry hives directly brokered (less than 5%), Bee brokers play an important role in the almond pollination industry –setting price/colony and ensuring minimum hive strengths are maintained for effective pollination. They play an important role in improve communication and trust between grower and beekeeper. Improve grower and beekeeper understanding of specific management issues such as fungicide applications required, insecticide use. Good brokers not only set the price but provide training and learning between beekeepers and growers.

- Brokers also provide inspection services. Good brokers will inspect hives to ensure minimum strength obtained within a few days of hives entering the almond crop rather than assess hive strength at midway through pollination when hives have built strength.

- Some growers will use a broker to source a small percentage of hives however most deal direct with beekeepers.

- Bee keepers generally increase hive strength on almonds however strength will be influenced by weather conditions. If a cold pollination period and limited pollination hours, hives may come off almonds in a poorer condition.

- Large beekeepers using a lot of unregistered products for *varroa mite* control. Tactic (Amitraz) is widely used.

- Beekeeping sites are now a highly competitive industry. Beekeepers now bidding for the right to retain sites.

Insecticides and the chemical companies

- Modern conventional agricultural systems depend largely on application of insecticides.

- New compounds cost 230 million Euros to develop. Generally, only one new active ingredient is released per year and these take approximately 8 years to develop and screen from 100000 new “discovery” molecules developed each year.

- Syngenta turns over $830 million/year and has approximately 20% of the Agricultural Chemical market. Bayer has 21%, Monsanto 19%, BASF 15% DuPont 15% and Dow 10%

- Many insecticides are neuroactive substances affecting central nervous systems of insects.

- Neonictinoids represent the fastest growing class of chemicals worldwide. Imidacloprid developed in 1970's by Bayer Crop Science (BCS)

- Besides acute toxicity of neonicinoids causing direct bee death, they can also affect bees in other ways. Sub-lethal doses affect behavior. Accumulation of substances in the wax, pollen or honey may cause yet unknown long term effects such as reduced cognitive abilities affecting learning and memory which can affect efficacy of foraging. Resistance to *Varroa Mite* to miticides is also partly driven from misuse of products. Under dosing can fast-track resistance levels and overdosing can cause build up of product in wax, honey and pollen.

- Strategies to reduce pesticide poisoning are as follows. 1. Reduce applications around flowering to avoid direct contact. 2. Seed dressings to minimize free insecticide in the environment. 3. Highly species specific substances have been developed that are less toxic to bees. 4. Repellent chemicals mixed with insecticides to reduce bee foraging during application. 5. Genetically modified organisms that carry genes that encode Bt-toxins that are highly specific for certain pests. Bayer Crop Science and Syngenta making significant investments in all areas of pesticide development.

- Investment in bee health and safety is second only to investment in human health and safety. Pesticides are a highly emotive issue. Communities are commonly identifying pesticides as the cause for damage to and changes to bee populations. Comment from one large beekeeper in the USA – "chemical companies are not supporting investment in toxicology studies due to continuous griping from beekeepers!"

- Misuse of insecticides is one of the reasons for bee losses where insecticides are involved, not the insecticides themselves. For example, Imidacloprid seed dressing treatments were thought to be responsible for the decline in bee populations throughout Europe which resulted in the banning of the products use in France for many years. A decline in bee health was thought o have occurred as a result of imidacloprid poisoning through pollen transfer. Other damage to bee populations has occurred where products have been mis-applied. Imidacloprid poisoning has occurred as a result of bees feeding on leaks in dripper systems where imidacloprid was applied through an irrigation system.

- Rhine Valley 2008– 11500 hives damaged due to clothianidin seed dressing being re-applied to maize seed. Chemical did not properly adhere to seed. In addition, air seeder used to seed crop had excess air generated blowing seed dust (and hence chemical) directly upwards into the air resulting in bee losses. Issue is not so much the pesticide used but poor application technique resulting in losses. Much publicity throughout Europe on this issue. Environmental lobby groups calling for bans on pesticides as a result of the misuse of the product.

- Syngenta has a Seed Care Institute at Stein (near Basle) to improve fungicides and pesticide seed dressing safety. Seed treatments provide a safer way to apply chemical treatments whereby off target damage is less likely providing applied correctly.

- Miticides need to be very different from insecticides as so can clearly identify where hive residues are coming from.

- Pesticide testing by chemical companies is extremely rigorous. Bayer site at Hofchen dedicated to honeybee research with pesticides. Range of other pollinating species also tested at this Research Centre.

- Testing to European Plant Protection Organization standards. Minimum standards are Lethal Dose (LD 50) tests only. Bayer and Syngenta testing far in excess of minimum requirements.

- Spray during bee flights in a closed environment. Studies include feeding studies, residue tests in honey, wax, pollen and nectar. Not only LD 50 testing but observations made on bee brood development, nectar and pollen accumulation studies.

- In addition, behavioral observations are conducted including measurements on foraging activity and flight activity.

- Universities, Bee Institutes undertaking behavioral studies using transponders attached to bees to monitor time in and away from hive. Foraging and social behavior studies investigating accumulation effects of pesticides on foraging times.

- No new, highly specific chemistry is on the immediate horizon. Very costly to develop with limited market access as so specific. Cost is 230 million Euros per new product.High levels of resistance developing to older chemistry.

- Focus on Integrated Pest Management (IPM) friendly chemistry which will reduce damage to beneficial insects.

- Pesticide resistance is a global problem. To maintain productivity and quality, growers will need to engage IPM practices as resistance develops to existing chemistry.

- Secondary poisoning – transpired chemical affecting bees – particularly at early growth stages.

- Bayer testing older chemistry that has been on the market for many years where there is no specific testing required when the products were released.

- Resistance developing more rapidly because bee keepers not following application procedures properly. Application and therefore exposure to acute doses of miticide are not occurring as manufacturers prescribe. *Varroa mite* is developing resistance to miticides as a result of under-dosing or repeated application of the same product applying selection pressure resulting in resistant populations.

- Many bee keepers/ lobbysits believe research done by chemical companies is biased and that good scientific practice and due diligence to product development is not applied. Bayer and Syngenta both demonstrate a significantly higher level of product development investment than authorities require. Testing for safety of new and older products that are no longer under patent protection is occurring.

Community attitude to food production

- Awareness and hence attitude to the importance of bees for pollination of food crops varies between the US and Europe. Food security concerns are still a high priority in Europe and Britain as a result of food rationing in the Second World War. These attitudes are supported by the farm payment schemes. Alterations to the schemes have seen payments decoupled and include entry level and higher level schemes. Payments associated with higher levels schemes are designed to increase biodiversity in the environment.

- The agricultural community is aware that food security will again be an issue as populations increase and production increases required to feed the growing population will not be able to be sustained. This information is being transferred to the general community in Europe.

- Role of pollinators (bees) is generally good in Europe. Supermarkets (Sainsburys) have financially supported operation pollinator programs in the UK. This support has benefitted the consumer more than the food producer. Supermarkets are demanding higher levels of pesticide accountability from vegetable wholesalers. Despite the extra work required from the supply chain to provide the evidence regarding safe pesticide practice, supermarkets are not paying premiums for food that passes higher food safety standards.

- From a supplier and producer perspective, a higher degree of pesticide accountability is required simply to maintain access to markets and certainly to gain access to premium markets.

- Awareness of the importance of pollination in food production in the USA has improved as a result of large hive losses brought about by CCD. Varroa Mite incursion in the mid 1990's had little impact on the general population. Varroa Mite was seen as "just another management issue" for beekeepers.

Operation Bumblebee and Operation Pollinator

- The bumblebee is an important and recognized crop pollinating species. Its effectiveness as a pollinator is extremely good. There is a large number of bumblebee species, all with different attributes. Long tounged bumblebees are particularly useful as pollinators.

- Operation Pollinator is a 5 year EUR 1 million program, supported by Syngenta in 2009 to provide habitat and food sources for pollinating insects across Europe. The project aims to boost numbers of pollinating insects in order to protect biodiversity and improve crop yields and crop quality.

- The project is based on the success of Operation Bumblebee in the UK where bee populations were increased by up to 600%, and other insects were increased in number 10 fold.

- Operation Pollinator is currently being run in the UK, France, Germany, Hungary, Italy, Spain, Portugal and the USA. The project uses scientific research findings to develop site specific ways of creating habitats alongside the working farm environment.

- Operation Pollinator programs have linked with Entry Level Stewardship (ELS) and higher level stewardship schemes which are voluntary, non-competitive schemes to encourage farmers across a wide area of farmland to deliver simple yet effective environmental management.

- The scheme requires a basic level of environmental management and participants can choose from a wide range of more than 50 management options. These cover all farming types and include things such as hedgerow management, stone wall maintenance, low input grassland, buffer strips, and arable options.

- Each year participants receive a payment for all the land entered into the scheme. In return they will be required to deliver land management options on land in the scheme. The standard payment rate is £30 per ha.

- Higher Level Stewardship (HLS) aims to deliver significant environmental benefits in high priority situations and areas. It involves more complex environmental management. HLS agreements are for ten years. Payments are sent out every six months and relate to the options that have been chosen. HLS includes payments for capital items such as hedgerow restoration.

- Programs within this scheme can result in payments of up to approximately 480 pounds/ha for floristically enhanced grass margins and wild birdseed mix plots. These schemes cover the cost of establishment and management of these set aside areas and provides suitable alternative income commesurate with existing cropping options.

- The single payments and agri-environment scheme payments thereby constitute a significant form of social engineering whereby land managers are being paid to continue

farming, both for socio-economic reasons and because their natural environment requires ongoing investment.

- As such these schemes assume environmental benefits. The success of similar schemes in Australia that are unsupported by subsidized payment systems will provide far greater adoption challenges as the relative advantage of such schemes is not evident to the farming community.

- Research into changes in floral and wildlife populations in areas subject to similar habitat changes is required in Australia. Examination of suitable species for specific locations will be required. Experience in Florida suggests finding enough suitable native floral species to satisfy habitat changes required to support increased populations and diversity of pollinating species might be difficult. Introduction of exotic species should be examined.

- Native bee species matched to the specific crop type are far more effective in crop pollination than honey bees. Honey bees are very effective in harvesting pollen but are inefficient pollinators of pulse crops and the honey bee harvest process sterilises pollen.

- Matching pollinator host plants to the flower properties of the target crop is critical in building population levels of suitable native pollinators.

- Provision of suitable nesting conditions and habitat is critical in building native pollinator populations.

- A very small percentage of host plant area, to target crop area, is needed to build pollinator populations to achieve adequate crop pollination. Common practice is a host plant area of 1-2%. There is little gain in natural pollination as the host plant area is increased above 5%.

- The host area will vary depending on the number of species being targeted, simply because different native pollination species require different flower types which increases the area required. In certain cases the host plant area can be less than 1 % of the target crop area.

- European understanding of pollination is far greater than current Australian levels and can be applied in our environment with our native bee species, native plants and crop types.

- Building populations of native pollinators has reduced agricultural reliance on honey bee pollination and lessened the impact of *Varroa Mite* on agricultural production.

Promotion of the Churchill Fellowship and activities since returning to Australia

- Developed "Operation Pollinator" proposal to with Ag Ex Landcare Facilitator, Michael Richards. Submitted to DWLBC for funding.

- Met with Syngenta, Marketing Head Australasia to discuss development of Australian pilot of Operation Pollinator program. $15,000 commitment from Syngenta to support Mike Edwards to travel from UK to Australia in September to conduct field studies and meet with key ecologists and farmer groups. Additional $35,000 from Northern and Yorke region, Adelaide Mt Lofty region and Eyre Region Natural Resource Management boards to fund scoping study to engage key personnel in discussion on Operation Pollinator program and develop strategy and funding for future developments.

- Met with Dept of Agriculture, Fisheries and Forestry's representatives at meetings at Kadina (date) and Crystal Brook (date) to discuss support and development of "Operation Pollinator"program scoping study.

- Meeting with state Minister for Environment and Conservation, Hon Paul Caica MP on July 21 to discuss state government support programs for "Operation Pollinator" program.

- Meeting with Shadow Minister for Agriculture, Food and Fisheries, Mr Adrian Pederick MP, and member for Wakefield Mr. Steven Griffith MP with the Yorke Peninsula Alkaline Soils Group on Wed 7th July. Discussion on "Operation Pollinator" program development.

- South Australian Apiarists Association AGM –Goolwa. Delivered address on Churchill fellowship study tour June 11th.

Articles/Promotion

- "Bill Long awarded Churchill Fellowship" – Yorke Peninsula Country Times. October 7, 2009

- "Mites could cost SA $300m" – Stock Journal -Jan 21, 2010

- "Beware the Varroa Mite" – Stock Journal- June 10, 2010

Key recommendations

1. Raise awareness of the threat *Varroa Mite* poses to feral populations of Apis Mellifera and the subsequent impact on crop production.

2. Identify the value and range of alternative pollinating species that exist that will act as a buffer when *Varroa Mite* incursion occurs.

3. Support the development and linkages of research organisations engaged in pollination research, production systems, ecosystems and honeybee management. (e.g. Pollination and Honeybee Research CRC.)

4. Registration of a range of pesticides for the control of *Varroa Mite* is essential. Organise permits and registration of miticides for the control and management of *Varroa Mite*

5. Develop training programs for apiarists to deal with *Varroa Mite*.

6. Build knowledge of alternative Australian pollination species.

7. Build knowledge of habit development required to increase pollinator numbers.

8. Establish and develop a team to develop and share knowledge and develop communication programs that link ecosystem management programs to improved agricultural productivity through improved pollination and pest insect management.

9. Increase farmer and industry knowledge of the range and types of Australian native pollinators through conducting preliminary field inspections and field studies.

10. Develop practical strategies to enhance and link areas of biodiversity.

11. Develop collaborative stewardship programs to improve farmer, advisor and consumer understanding of the importance of responsible pesticide practice.

12. Support the development of IPM practice amongst the farming community.

13. Develop Operation Pollinator programs within Australia. Establish partnerships with food companies such as Woolworths and Syngenta to promote and develop consumer understanding of safe food production practices and importance of pollination in food production.