Nuffield Farming Scholarships Trust

An Alan and Anne Beckett Award

Halting the decline of the honey bee

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EXECUTIVE SUMMARY

Since 2007 there have been almost daily newspaper and television reports, some more factual than others, about the decline in honey bee populations. So what's been going on?

I am a commercial beekeeper with over 1000 hives and have had my fair share of problems with our bee colonies dropping below 50% in some years. Due to disease and a declining number of beekeepers, managed hive numbers have reduced nationally by a similar percentage, without recovering, over the last fifteen years. There have been many non-scientific theories as to what will happen to the world's food production if pollinators disappear.

"If the bee disappears from the surface of the earth man would have no more than four years to live."

Is the above much-used Einstein quote an urban myth or is it fact?

The Parliamentary Office of Science and Technology estimates that about 13% of UK farm income is derived from crops that need pollination. There is no doubt that bees are important for agriculture but they also help sustain the wider ecosystems that we all take for granted.

The reduction in bee colonies in recent years has been a worldwide phenomenon but with no common link. Many of the problems in Scotland have stemmed from poor summers which have led to smaller, weaker colonies which become more susceptible to disease. We cannot control the weather. However, we can make sure that the bees are healthy and in good condition when the weather does improve, so that the bees can achieve good crop pollination and produce commercially viable honey harvests.

The opportunity to travel to countries with similar problems and look at how they deal with them has already been invaluable to me.

This will be the first UK Nuffield report written by a beekeeper to examine the many problems faced by our industry in recent years. I hope the information contained in it will be used by beekeepers, both large and small, to improve the health of their bees. It may also suggest to the wider agricultural community how farmers and beekeepers can help each other.

MY BACKGROUND

I am very proud and honoured to have been selected as the first British beekeeper to have been awarded a Nuffield Scholarship in the latter's 50+ year history. The many problems beekeepers have faced recently have highlighted the importance of bees to farming and I hope my studies will improve the beekeeping situation in the UK and therefore benefit the wider farming community.

I spent the first 13 years of my working life in the Metropolitan Police on the streets of London during which time I was encouraged to keep bees by my father and grandfather who were both hobby beekeepers.

In 1999 I left the Police Force and moved back home to Perthshire, Scotland with Edel, my wife, and started a commercial beekeeping business with 30 hives and borrowed farm buildings. This has grown to over 1000 hives and a purpose built British Retail Consortium and Soil Association accredited facility where we pack our own honey and also imported honeys for supermarkets and other distributors with their own brand names. During this time we have also managed to produce four fantastic children.

Disclaimer

The views expressed in this report are my own and not necessarily those of the Nuffield Farming Scholarships Trust or my sponsors or any other sponsoring body.

INTRODUCTION

The beekeeping industry in the UK had remained largely unchanged for many decades until the advent of Varroa, a parasitic mite, which reached the UK in 1992. The industry responded to Varroa initially by using licensed chemicals and more recently by applying organic treatments as the mites became resistant to the chemicals. Wild and feral colonies died out and beekeepers who did not combat Varroa lost their colonies after a few years thus reducing the overall bee population considerably. All honey bees on the UK mainland now come from beekeepers' hives.

Managed hives declined by around 50% in the UK between 1985 and 2005. It is estimated that there are around 44,000 beekeepers in the UK. Of these 99% are hobby beekeepers, maintaining about 274,000 colonies. The figures are estimates from DEFRA as there is no compulsory registration and, although there are numerous local associations, not all beekeepers are members. The remaining UK beekeepers were better informed but still continued to manage their bees on traditional lines until 2009 when a disease called European Foulbrood broke out in Scotland on an unprecedented scale.

The four wet summers of 2007-2010 were very challenging for bees, producing low nectar and pollen stores in the hives which resulted in poor honey crops. Owing to their reduced size and inadequate nutrition many colonies succumbed to disease, especially European Foul brood (EFB) and American Foulbrood (AFB).

> **EFB** is a bacteria which forms in the gut of the larvae and is generally seen as a stress disease becoming more common when hives are weakened through lack of nutrition.
>
> **AFB** is a spore forming bacteria, also affecting the larvae. AFB is a much more serious disease which, left uncontrolled, will destroy the colony.

It is currently thought that the Varroa mites act as a vector for EFB and AFB spreading the bacteria around the hives. AFB spores live for many decades and can only be destroyed by fire or cleansing procedures involving caustic soda. These are notifiable diseases and are treated in a similar way to TB in cattle. Government bee inspectors examine colonies, post standstill orders where necessary and, in the case of American Foulbrood, order immediate destruction, without compensation.

During 2007-2010 the disease situation was very serious in Angus, Fife and Perthshire. The number of empty hives meant that over 50 million bees were not available for pollination and this had a serious impact on the important Tayside soft fruit industry. Pollination value to agricultural crops is estimated at over £12 million in Scotland and up to £200 million for the UK as a whole. So what was to be done?

Beekeepers, officials and politicians in Scotland were caught unawares and ill-prepared. Everyone had just assumed that bees were always around.

The problem of bee disease control and treatment in Scotland was exacerbated by the virtual absence, pre 2009, of any adequately funded contact between beekeepers and officialdom. There was no contact with politicians. This has changed dramatically since the 2009 disease outbreak in Scotland. We now have a well-funded and resourced government programme of inspections and diagnosis.

STUDY TOUR OVERVIEW

My experience over the past decade has been Scottish based but I have been a member of a UK beekeepers' delegation to Brussels and am well aware of the regulatory arrangements in England and Wales. Consequently I focussed my Nuffield Scholarship entirely on Australia and New Zealand where I had excellent contacts and it made sense to travel to the southern hemisphere in February/March when it was the height of their beekeeping season but the low season in Scotland.

We have three main hive problems in the UK:

- Varroa
- European Foulbrood
- American Foulbrood

Australian has EFB and AFB but no Varroa.

New Zealand has Varroa and AFB but no EFB.

Both countries have put extensive controls in place to stop the transfer of disease and parasites. These controls are very much industry led which could become relevant in the UK, e.g. should there be cuts in the government funded inspectorate.

My Nuffield Scholarship enabled me to compare the UK and European bee management procedures with the situation in Australia and New Zealand. I will be sharing with UK beekeepers the helpful information which was willingly and generously provided by all the beekeepers whom I met 'Down Under'.

WESTERN AUSTRALIA

First stop on my trip was to see Paul and Desiree Koch in Perth, Western Australia. We had not met personally before but I know their honey well as we have been packing it for over a year.

When I arrived they were having bushfires almost daily and Paul had a water tank and pump on his truck to fight fires. I pointed out that we had just had a snow plough made to cope with our climate! He also needs the pump to fill water tanks on his bee sites. The bees land on floating mats and carry water back to the colony. About 2 litres is evaporated each day within the hive to keep it at an optimum temperature for brood rearing.

The beekeeping in WA is fairly simple. A low management approach is used. New queens are introduced at the beginning of the 10 monthly season and the bottom brood boxes are rarely examined. If the beekeepers see an obvious problem when collecting honey they attach a nucleus hive with a new queen. They have almost continuous nectar flows but have to select sites carefully as the lack of rain can mean that the mainly tree flower crops may not yield in one area but 100 kms away they might be productive.

I was particularly interested in Western Australian disease control. This is achieved in two ways. Firstly, there is a queen breeding station on Rottnest Island to which eight beekeepers send their best stock. The island is free from feral bees and therefore it is possible to have some control over the mating process. The beekeepers are able to select eggs from strong healthy hives for the breeding programme.

Secondly they operate a very high level of bio-security. They never transfer frames between hives. When the honey boxes are collected from the hives they are numbered and colour coded in such a way that once they have been through the honey extraction plant the same frames and boxes are returned to the same hives from which they were taken originally. I was surprised and impressed at how effectively this procedure had been developed.

Observations from Western Australia

- Almost perfect bio-security
- Attention to genetics
- Low management

see picture of Western Australian hives on next page

Western Australian hives

SOUTH AUSTRALIA

My next visit was to Tintinara SA, two hours east of Adelaide. Here I was looked after by Ben Hooper and his wife Jo. Ben was an Australian 2010 Nuffield Scholar also looking at bee diseases, particularly Varroa, a parasitic mite, endemic in Europe and New Zealand but not yet present in Australia. I stayed with Ben and Jo for five nights although they were away for two of those nights; such is the trust within Nuffield.

South Australia's beekeeping is vastly different to that in Western Australia. There are massive acreages of arable and bush-land flowers, and 400 hives are often placed within sight of each other, whereas in the UK we would be restricted to 25–30 hives on one site as there is not sufficient crop for the bees to harvest.

As in the UK, beekeepers also practise brood nest management. They inspect the eggs and brood at each nine day visit to ensure all is well. If they see a problem, or even anticipate a problem, they replace the queen bee. This system relies on weekly deliveries of 50+ queens with attendant workers to ensure the system is viable. The advantage of this is that as well as re-queening the hive the attendant bees provide a five frame boost of bees and larvae for the colony. The hives remain strong and healthy which makes them less prone to disease.

During pollen dearths a pollen substitute, "BEE FEED", is provided. Pollen is important to the hives as this is their main source of protein and is fed to the larvae. If there is no pollen then the queens will stop laying eggs, reducing the size of the colony. Resulting from my observations in South Australia I purchased about half a ton of pollen feed this year for the first time and have seen a marked difference in hive strengths. The bee colonies have remained strong although the weather has been poor and the bees have had less opportunity to forage.

The other main method of disease control in South Australia is mobile honey extracting. A purpose built trailer is taken to the bee site, within which is the machinery needed to spin the honey from the combs. This ensures the combs remain on that site and, although not as secure as the Western Australia bio-security system, if disease is found on the site it can be contained.

see picture on next page : Mobile honey extracting

The third area of interest for me in Australia was the highly efficient mechanisation of their beekeeping. The Australian beekeepers were all running large 4x4 trucks capable of carrying 100 hives a load. They would place 4 hives on a variety of differently designed pallets and load, or unload, using either lorry mounted cranes or 4x4 forklifts towed on trailers. The efficiency was impressive, typically taking about 2 hours to load, strap, and get on the road. The vast amounts of nectar bearing flowers plus the large expanses of land on which 100 hives could be sited, makes this a very productive operation, something not achievable in the UK.

Mobile honey extracting

Ben and hives

Ben and I discussed at length my experience of Varroa and the possible impact on the Australian beekeeping industry. Once it gets to Australia, Varroa will kill their feral bees and bees owned by incompetent beekeepers. Each of these sectors also harbours other diseases which can contaminate well managed colonies. We agreed that, in this sense, the Varroa mite could bring some benefit in the disease control context!

Killing feral bees

Observations from South Australia

- Concentration on re-queening
- Nutrition and disease prevention
- Bio-security at apiary level

see overleaf for Conclusions re the whole of Australia

AUSTRALIA – My Conclusions

My conclusions from the Australian trip are :

1. It is a vast country with massive flower sources.

2. Their hives produce up to 150 kg each season compared to about 30 kg in the UK.

3. They have highly efficient units using minimum labour, typically extracting 300 deeps, 8 barrels in a day compared to a couple of barrels per day in an efficient UK plant.

4. Bio-security is very good and Australian beekeepers work well with the government departments and officials who are tasked to help them.

5. The beekeepers I met are young, entrepreneurial businessmen and very well informed about what is going on in the rest of the world and are prepared for any threats to their industry.

6. We in the UK can learn from the Australian example in some of these areas.

Observations from my Australian trip in general

- Bio-security at hive level WA)
- Bio-security at apiary level (SA)
- New queens always available
- Hive nutrition

NEW ZEALAND

Whilst I was in New Zealand Christchurch suffered a devastating earthquake killing many people. This had a profound effect on the small population and was a difficult time for some of my hosts. However, Kiwi resilience meant that I was welcomed wherever I went and they went out of their way to assist me with my studies, for which I am most grateful.

My first host in New Zealand was Russell Berry from Arataki honey. I first met Russell and his wife Annette a year earlier when he accompanied some "immigrants" to Scotland. The "immigrants" were several million bees and their queens flown in on a 747 to help restock our own hives. This was the first time bees had been brought to the UK from New Zealand but Arataki have been shipping bees all over the world for many years. This is a complex process mainly ensuring the bees are kept at a low temperature. Russell and my sponsor, Alan Beckett, have much in common. Each has many diverse business interests. Russell is involved in all areas of beekeeping in New Zealand. He is a beekeeper, queen breeder, package bee exporter, honey packer and exporter, propolis and pollen merchant, shop, petrol station and hotel owner .... and I'm sure there were more! He was a fantastic contact in NZ as he has been involved in, and run, most bee related organisations. He sent me off with a list of beekeepers to visit all over the North and South Island. He gave me a map with all sites marked on it and also contacted the beekeepers in advance to pave the way. With such a short time available to me I could not have asked for more and I am very grateful for his help.

Much of New Zealand has a not dissimilar climate to our own, although average temperatures are warmer. Some of the forage for bees is similar to ours in the UK.

New Zealand has had Varroa for a similar length of time as the UK. They have American Foulbrood but not European Foulbrood and are very worried about getting small hive beetle and European Foulbrood from their neighbours in Australia.

I met Dr. Mark Goodwin, New Zealand's leading apiculture scientist, from the Ruakura Research Centre, part of The Horticulture and Food Research Institute of New Zealand. Unlike the UK situation his work is mainly funded from within the industry and, as well as looking at disease, he also specialises in pollination of the kiwi fruit, a key NZ export industry. He explained that from 1906 to 1990 the New Zealand government funded a total eradication programme for American Foulbrood and inspected between 5% and 10% of hives as well as keeping a register of hive locations.

However, in 1991 the government announced it would no longer fund the AFB (American Foulbrood) control programme. The National Beekeepers Association (NBA), the industry representative body, applied a levy to beekeepers dependent on size and this funded the continuation of the AFB control programme.

Beekeepers were encouraged to become 'Approved' beekeepers. To do this they had to demonstrate they were competent at spotting and destroying AFB and had a plan to eradicate it from their colonies. Those not 'Approved' have to be inspected by an Approved beekeeper every spring. The programme also funds field days, seminars and other educational functions. There are follow up audits and the NBA has legal powers to carry out remedial work on behalf of beekeepers who fail to meet their responsibilities. It is always dangerous to draw conclusions from statistics but when the government carried out inspections the AFB levels were at their highest and, nine years after the industry took over, they were at their lowest.

There were two similarities between the UK and NZ when Varroa arrived. The beekeepers took their eye off the AFB problem and concentrated on Varroa management causing a slight increase in AFB findings. The second effect of Varroa was to wipe out feral colonies and the colonies of incompetent beekeepers both of which harbour disease.

After much discussion Dr. Goodwin was amazed at our intensive bee management and lack of queen replacement. In his opinion many of our problems were due to insufficient re-queening which resulted in weak hives and consequent vulnerability to disease. He explained that most beekeepers in New Zealand re-queened every year with mated queens, or more recently with queen cells, and they had seen dramatic reductions in AFB. They were still treating Varroa with a number of chemical strips in much the same way that we have done in the UK. I discussed our experiences with mites that had become resistant to the pyrethroid chemicals and he thought this would be the next challenge for New Zealand.

On the North Island I met beekeepers with 600, 1,000 and 16,000 hives respectively. Most were specialising in Manuka honey. Prices for this honey are very high as we are all aware, so there is a major incentive to have strong and active colonies to maximise the Manuka harvest. This has been a big boost for the industry. Before the research was done into the anti-bacterial properties of Manuka honey some beekeepers fed it to animals or buried it in the ground! They were also collecting by-products such as pollen and propolis for which there were markets in Japan and China, countries they are actively targeting. In recent years there have been aggressive moves by some beekeepers to get into the best Manuka areas, going to farmers and out-bidding their competitors which is not a UK characteristic. Ironically the other notable difference from the UK is that New Zealand beekeepers are prepared to co-operate more closely in other respects – e.g. honey extracting.

After speaking to beekeepers all over the North Island I took the ferry over to the South Island. I was extremely fortunate to be hosted by Murray Bush, a beekeeper with a couple of thousand hives. Murray spreads his hives out in order to get a diverse range of honeys. One of the places he takes them to is Molesworth Station. This is New Zealand's largest farm at 180,000+ hectares on which 10,000 cattle are grazed. It has a range of altitudes, from 550-2,100 metres and therefore has extremes of temperature. It is operated by the Department of Conservation and Murray runs several hundred hives on the property. Murray only goes there very infrequently as it is a two and a half hour drive just to get to the front gate and then you could spend days driving around the property. He stores equipment there and when he and his team go to work the bees they stay for several nights in a former logging cabin. The ground is extremely poor with scrubby grass and wild flowers and almost no trees. The few non-native trees growing there were being cleared and, as they were so inaccessible, the forestry workers were being dropped by helicopter for the felling operation.

Murray Bush hives

Murray achieves good crops of honey but has to rely on a system of beekeeping which requires few visits. He does this by splitting hives late in the season and leaving adequate honey for the winter feed. In this way he generates new queens and colonies for the next year. South Island has only had Varroa for a few years and Murray's plan is to keep his hives on Molesworth in order to stay Varroa-free for as long as possible.

He was also very interested in our use of oxalic acid to treat Varroa as it is a one-time treatment when the hive is brood free, which his hives will be in the winter, whereas the use of chemical strips requires a return visit after 6 weeks to remove the strips. Of all the beekeepers I met Murray was the one who best understood that chemical strips only have a few years of application before the Varroa mites build up resistance to the active chemicals. One memory which will stick with me forever is sitting with Murray on the porch of a 100+ year old (that's a lot for NZ) cabin in the middle of nowhere looking out over many thousands of hectares of nothing, eating honey sandwiches and drinking cold water from a spring and of course talking about bees.

The pressure to pack in as much as possible into a Nuffield Scholarship trip meant that I left Murray that evening and caught the night ferry back to North Island, arriving at 1.30 am. I then drove for the next ten hours to get back to Auckland for my next 'appointment'. This was supposed to be a one hour visit to Peter Boutelje, one of the world's best manufacturers of honey extracting equipment.

Getting the honey quickly and efficiently out of the combs is extremely important. The heather honey in Scotland is a thicksotropic honey. It has an almost toffee-like consistency and will not 'spin' out in the conventional way. The Manuka honey in New Zealand has the same properties and so various extra bits of equipment are needed to loosen the honey before extracting it. Peter specialises in this equipment.

The Norwegians invented a machine whereby you place a frame of honey between two banks of needles and when you pull the handle down the needles go into the wax cells and loosen the honey. Peter had invented a semi-automatic version of this powered by air which made everything faster. I was only supposed to be with him for an hour but in his workshop was the world's first ever fully automated loosening machine! Peter's machine was cleverly designed to solve what has been a difficult technical problem. We ended up talking until lunchtime .... then into the afternoon .... and then he and his wife invited me out for dinner. Maybe he saw a potential buyer for the machine. I also noted that Peter had the most expensive car I had seen in New Zealand. The money the beekeepers make from Manuka keeps Peter's factory busy!

I had two more people to see north of Auckland. The first of these was described by Russell Berry as *'the best beekeeper in New Zealand'* and the other *'the best queen breeder in New Zealand'*. Another four hours driving.

The beekeeper was Brian Alexander. Brian's management techniques were as close to mine as any I had seen in NZ. He split hives and also reared second queens above dividing boards on the same hive. The big difference was that he had a very long season and ideal conditions for mating queens. He reared his own queen cells from grafts out of breeder queens. The resultant queen cells were then placed in the hives without even looking for the old queens. He also placed an enormous importance on hive nutrition. He fed pollen substitutes when necessary and left honey on for the bees to feed on over his short winter and so achieved a faster build up of his colonies in the Spring.

I worked some of his hives whose honey surplus had already been removed. The remaining boxes were very heavy with honey left on for winter feed. Brian's honey is not particularly valuable but he was leaving a lot of 'money' on the hives for the bees to eat. He claimed that this investment was more than repaid by strong colonies in the spring.

He was the first beekeeper I had spoken to who recognised that there were resistant Varroa mites in the North Island and he had switched away from the chemical strips to Apiguard, a thymol based product with no issues over resistance. I was extremely impressed with Brian's beekeeping and management and we talked well into the night about the problems we had in Scotland.

see next page for picture of Brian Alexander's hives.

Next I went to see New Zealand's best and most controversial queen breeder, David Yanke. To understand *why* he is controversial we have to look at the history of bees and beekeeping in NZ.

Brian Alexander's hives

The first European settlers brought bees with them. The importation of bees was banned at a later date although some colonies were illegally imported thereafter. The beekeepers worked with variations of the native bees and most commercial beekeepers were stocking hives with a strain of very yellow bee.

A small group of dedicated beekeepers felt that the NZ gene pool could be improved with other varieties, notably Carniolans, a darker bee. This is one of the best and most widely used European honey bees. It has many of the traits beekeepers want, it is very hardy, increases population quickly in the spring, has good production potential and is quiet to handle. It took David fifteen years to gain approval to import semen. It was the advent of Varroa in NZ that helped as he was able to put forward a case that an extended gene pool might help in the breeding of more Varroa-tolerant bees.

Six years on this importation plus very careful breeding programmes have produced a superb strain of bee now used by a growing number of commercial beekeepers in NZ. We have also had excellent results in Scotland importing the same stock. The visit to David's really brought home the value of using the right bee for the environment it has to work in, and that paying a bit extra for a better queen can lead to significantly larger crops with the same amount of management.

This leads on to the question of whether non-native species are always bad news. NZ takes border bio-security very seriously. I was searched at the airport on entering the country as I had ticked the box to say I had been on farms in Australia. I was questioned on the ferry between the North and

South island as they were trying to stop a waterborne plant from spreading. Experience shows they are probably facing a losing battle when it comes to bees. After trying to stop Varroa when it was first detected in the North Island they have now given up and I am sure it is only a matter of time before they have to deal with European Foulbrood.

The Australians, after spending a lot of time, effort and money have given up trying to stop the more aggressive and less manageable Asian honeybee spreading down from Darwin where it was first detected.

I believe that we should take the same approach as David and look for breeding solutions to our problems. Beekeeping should be no different from other livestock breeding improvements. I am sure most beef and dairy farmers are grateful that their milk and carcass yields are not what they were 100 years ago.

Varroa sign in New Zealand

see next page for Conclusions from my New Zealand trip

NEW ZEALAND – My Conclusions

1. The two islands of New Zealand have vastly different climatic conditions, ranging from tropical in the North to freezing sub zero temperatures during winter in the South. This leads to a large range of different beekeeping techniques some of which are similar to those in the UK.

2. Due to the need to export most of their honey there is a well-structured and mostly cooperative industry.

3. The biggest change recently has been in the value of Manuka honey, only produced in New Zealand and now one of the most expensive honeys in the world. This has generally been good for the industry but has led to fierce competition for the best Manuka producing sites with large scale, well-funded companies becoming involved.

4. I met some exceptional beekeepers with whom I remain in regular contact.

Observations from my New Zealand trip

- Industry led disease programmes
- Hive nutrition
- Regular re-queening
- Collaboration between beekeepers
- Need to co-operate carefully on improving gene pool

BRUSSELS

I first went to the European Parliament in 2008 with two other beekeepers, one from Scotland and the other from France. This was at the request of an MEP who wanted to understand more of what he was reading in the newspapers about the decline of the honey bee. This simple meeting grew to include attendees from the Commission, the then Chair of the Agriculture Committee, MEPs and other interested lobby groups. We were completely unprepared, e.g. no Powerpoint presentation, but spoke passionately about our industry and problems.

This led to a European Parliament resolution passed in Strasbourg setting out the problems we faced in Europe and how the parliament could assist. This was then used to shape EU policy leading to the latest resolution passed in 2010. I am the UK beekeeping representative on the COPA-COGECA policy committee which meets several times a year.

Beekeeping policy, as with other areas of agriculture, is very much shaped in Brussels. Everything from labelling to antibiotic residues is discussed. We work closely with the NFU, which some people find strange. Surely farmers spray crops which kill bees? **Since 2003 there have been no recorded incidents of honeybee poisoning in the UK resulting from the approved use of pesticides**. The commercial beekeepers work with farmers every day as we rely on farms for most of our lowland bee sites. Farmers work within commercial and political constraints and we have to adapt to the changing landscape. That is not to say as beekeepers we cannot influence policy and during the current round of CAP reforms we need to lobby hard for what we want and not be pushed aside by larger pressure groups.

One important result of my Nuffield Scholarship to Australia and New Zealand is that I will be in a position to contribute knowledge, gained first hand in these two countries, to the discussions in Brussels.

see picture on next page of an interview in Brussels

Brussels interview

LASI at the UNIVERSITY of SUSSEX

Laboratory of Apiculture and Social Insects at the University of Sussex is probably the largest bee research group in the UK. The director is Professor Francis Ratnieks, the UK's only Professor of Apiculture. I visited in 2010 and found a well-run and equipped facility with labs and hives on site. The most interesting project being currently run is to produce a particularly hygienic strain of bee. Hygiene is a normal part of hive activities but it has been observed that some colonies place more importance on this activity than on others.

This could have a number of benefits. Bees will have a greater urge to clean Varroa out of cells and remove larvae discoloured and affected by disease and therefore stop them from spreading more bacteria. Through a breeding programme it is hoped to produce queens whose offspring have a high level hygiene characteristic bred into them.

This is a good point at which to stress the importance of queens in the hive. The queen is central to the survival of the colony and to this end the bees will do anything in their power to keep her alive. No queen, no colony. The traits and characteristics of the queen's offspring are central to beekeeping. A newly hatched queen must leave the hive to be mated after about six days when the weather conditions are fine with light winds and warm temperatures. She will fly about one mile on average and the flight can take up to thirty minutes. She will fly several times and can mate with several drones until her spermatheca is full. Every egg laid by the queen is fertilised by a cocktail of semen and therefore tens of thousands of eggs, and subsequent offspring, are very slightly different.

The process of grafting eggs from a hive with the characteristics that the beekeeper requires is fairly simple. These eggs can then be put in a hive with no queen and the bees will turn them into queens (very simplistic!). So we have selected half the genes. The drones, the male bees, supply the other half during mating. Generally the beekeeper will take the unmated queens to a secluded area away from other beekeepers and will flood the area with hives containing selected drones. The queens fly and, if all goes to plan, are mated with these selected drones.

This must happen within a week and this is where we have problems in Scotland. If we have a week of poor weather then this mating process does not happen successfully and much time has been wasted. This is why we buy most of our queens from more southerly climes, as described below.

Queen breeders get around many of these problems by using artificial insemination (AI). Yes, the same principle as with other livestock but on a much smaller creature. The first process is the same, selecting eggs to turn into unmated queens. These 'virgin' queens are then artificially inseminated with semen from selected drones. In this way there is greater control over the breeding lines and the gene pool. This complex process cannot be used to produce large numbers of AI queens and also AI queens have a shorter egg laying life in the hive. The answer is to use AI queens to keep breeding lines going and further develop them but still have queens mated in the open in secluded areas.

To this end I have been looking at sending some of our best queens to Portugal, which has a warmer climate more conducive to queen rearing. The eggs from these queens will be used to produce virgin queens which will then be mated with selected drones in secluded areas. These queens can be ready for the beginning of our season and we will have greater control over the stock used rather than just buying in queens from an unknown source.

This project could be further expanded to produce small five frame colonies headed by our selected queens and then driven to Scotland, something we have done before with bees from Spain, ready to start our season. This would help us to achieve a beekeeping model similar to that in Southern Australia with all the advantages I saw there. This is only achievable as I have a former Portuguese beekeeping employee working over there.

SCOTLAND

I feel that it is important to highlight the enormous amount of work done in Scotland since 2009 and detail where we are now as I have been involved in this process during my Nuffield studies.

The industry has gone from near collapse with many beekeepers reporting 50%+ colony losses, to a much improved situation, although we are a long way from keeping this sustainable. In 2009 there was little contact between beekeepers and government. We receive no subsidies and are either commercial beekeepers struggling to survive or hobby small scale beekeepers. The two groups do not always share the same goals and aims.

When the disease problems broke there was no contingency plan held by government, although these are statutory diseases requiring government intervention. There were initially many table thumping meetings with ministers in Edinburgh as we did not know how government operated, and they had no idea of how we worked and managed our hives. Very quickly, however, some excellent civil servants from the Rural Payments and Inspectorate Directorate (RPID) were deployed. These are potato and cereal inspectors brought in to inspect hives. Happily many of them are beekeepers themselves and we soon established a good working relationship. Strategies and voluntary codes have now been drawn up by representatives from all areas of beekeeping and government.

We are also very fortunate to have the Scottish Agricultural Science Agency (SASA) in Edinburgh. Agency experts are more used to diagnosing plant and animal diseases. However they have become very skilled in looking at hive samples and diagnosing, within 24 hours, American Foulbrood or European Foulbrood or advising that all is clear. We have gone from nothing, in just over two years, to a very well-run and organised system for inspecting and diagnosing hive diseases. **I would like to take the opportunity in this report to acknowledge the enormous amount of work done by beekeepers and government personnel in such a short space of time.**

So where are we now? Much further on than a few years ago.

We are inspecting and diagnosing disease.

- We have BEEBASE, a national database for beekeepers, on to which we report our bee sites and are then automatically alerted by email to disease found in the area.
- The beekeepers are no longer so secretive. They now talk to each other either directly or at industry/government lectures and seminars.
- There has been some grant money to help restock hives but this is seen as an emergency one off payment.

see next page for The Future

The Future

Will there still be government funding for all these programmes? Finding the different diseases does nothing to deal with the root causes. This will be the next challenge to make our industry sustainable for the future. **Maintaining the health of our bees is central to our industry going forward.**

BDPC 01

SCOTTISH EXECUTIVE

Rural and Environment Directorate

BEES ACT 1980
THE BEE DISEASES AND PESTS CONTROL (SCOTLAND) ORDER 2007

STANDSTILL NOTICE

To: **Mr Andrew Scarlett**
Stripside
Longleys
Meigle
Perthshire
PH12 8QX

- owner or person in charge of the hives or other controlled items on premises situated at ~~and/or* under the control of~~:

Kippo
Middle Drums
Monikie
Pusk

The undersigned authorised person, appointed for the purposes of the Bees Act 1980 and The Bee Diseases and Pests Control (Scotland) Order 2007, having reasonable grounds for supposing that a disease, notifiable under the Order, is present on the above-mentioned premises/~~having been refused entry to the above-mentioned premises*~~, hereby gives you notice that no hive, bees, combs, bee-products, bee pests, hive debris or appliances may be removed from those premises, except under the authority of, and in accordance with the conditions of a licence issued by the Scottish Executive, until this Notice is withdrawn by a further Notice (BDC05(S)).

***Delete as appropriate**

SCOTTISH EXECUTIVE

Signed:

(Authorised person)

Date: 7th June 2011

NOTE: (1) Any person who contravenes or fails to comply with the provisions of this Notice or the Order shall be liable on summary conviction to a fine not exceeding £5,000.

(2) Licences will not normally be issued in the eight weeks following any treatment of the bees.

BDPC 01

Government standstill notice

Bees at heather (Scotland)

SCOTTISH BEE SERVICES LTD

The observations from my travels convinced me that we could do more in the UK to help ourselves.

A small number of beekeepers in Perthshire, Scotland, has come together to look at what can be done collectively to reduce our disease problems.

The problem disease is American Foulbrood as the spores can live on the combs in the hives for decades and can only be destroyed by fire or harsh chemical treatments. The idea of a sterilising plant was put forward by one of our beekeepers. Sterilising is achieved in Australia and America by irradiation but there are no facilities in the UK. The other method is a caustic soda treatment and there are two examples in Europe.

The Perthshire beekeepers have formed a co-operative (Scottish Bee Services Ltd) to build and operate a caustic plant in the centre of Perthshire for treating bee frames in order to prevent diseases. Business plans and financial projections were prepared and submitted with an application for government funding. In July 2011 nearly 100% funding was obtained from three sources: Perth and Kinross Council, Scottish Enterprise and LEADER funding.

Not only did we get funding for the plant but also for a project entitled Bee Health and Pollination Awareness. This second project is aimed at improving the available forage for bees in the countryside and therefore increasing hive nutrition. The forage project resulted from an earlier Scottish Agriculture College scheme in which farmers were encouraged to grow bee-friendly crops wherever possible.

We also aim to look at how we can generate higher value nectar and pollen yields from mainstream agricultural crops and communicate this information to farmers.

The Perthshire sterilising plant is being viewed as a nationally important project, a first in the UK, and it is hoped that by beekeepers putting their frames and hives through the plant American Foulbrood and European Foulbrood will be dramatically reduced. This plant will be available to any beekeeper in the UK. Once the plant is up and running one idea is to then run an accreditation scheme whereby beekeepers who use it, gain a 'high health' status. Consequently they may require to have their hives inspected less frequently.

In the future the co-op, as a representative body, could go on to be a vehicle for other projects and source further funding.

AGRICULTURE and APICULTURE

> *'Pollination has a direct economic value through increasing the yield and quality of insect dependent crops. In the UK this includes oilseed rape, orchard fruit, soft fruit and beans. Total loss of pollinators could cost up to £440 million a year, about 13% of UK income from farming. Pollination through its essential role in maintaining biodiversity and ecosystem functioning also provides indirect benefits to agriculture. These benefits have not been valued but probably exceed its direct value.'*
>
> Parliamentary Office of Science and Technology report January 2010

My studies have helped me get a better understanding of how the agriculture industry works in the UK. Normally beekeepers go along to a farm with some promising crops, put the bees down and hope for some honey. What variety of seed was planted? Does it yield a lot of nectar and pollen or not? The farmers had no idea. This knowledge was not available to them - they just knew they wanted bees on their farms.

After a meeting with Dr Elaine Booth from the Scottish Agricultural College (SAC), an oilseed rape expert, I learned that the College conducts field trials for the Home Grown Cereals Authority (HGCA). I explained that beekeepers were sure some varieties of oilseed rape produced more nectar and pollen than others but they lacked hard evidence. This was something she was unaware of but was interested to explore. Could new varieties be tested during the field trials for nectar and pollen yields? Only if the HGCA agreed as they paid for the trials. I approached the HGCA who were very enthusiastic but ultimately, they said, the trials were paid for from a farm levy and this would complicate things.

I next thought: why don't we go to the seed source – i.e. the companies that produce the new plant varieties? Could they include nectar yield and pollen traits in their new varieties? Could this information be passed to the farmers in the 'recommended' list produced by the HGCA? All the farmers I spoke to said they would grow a high yielding nectar and pollen variety if it helped bees and other pollinators, as long as the seed yields were not reduced.

There are some small scale trials going on in England this year. Beekeepers understand that farmers have to make a living and run their farms profitably but, given the information, most farmers, I suspect, would grow a variety that was beneficial to bees and other insects. The companies who incorporated bee friendly characteristics without loss of product yield in their seed could generate a competitive advantage. The beekeepers would gain from producing more honey. It does not sound difficult. It is an area of cooperation which I will continue to promote.

There are other areas where farmers can help. Small changes to sowing times and leaving a week or two between sowing times in different fields of oilseed rape can lengthen the season for honey production. Some of our best years result from poor September weather when farmers failed to sow all their oilseed rape on consecutive days. The following spring the staggered flowering times extended our season.

We are looking at a new project with one of Scotland's largest soft fruit growers, P J Stirling Ltd, whereby the bees deliver the fungicides in order to reduce the frequency of spraying strawberries for botrytis.

A study was carried out at the New York Experimental Station between 1994 and 1997 which showed that **fungicide delivered by bees reduced spraying by half and increased seeds in the strawberries by 22% and the fruit weight between 26% and 40% more than berries in non-visited treatments.** This would be a considerable saving in spraying costs for the farmer as well as an increase in yield. **There would also be a legitimate merchandising case to be made by supermarkets.** This is something we will trial with the farm next year and will investigate whether there is any funding for a properly controlled evaluation.

Other good crops for us include spring sown oilseed rape, borage, beans, fruit trees, soft fruit and phacelia. Some months of the year it appears that there is plenty for bees to harvest but actually June is always a problem month as there are very few viable plants in flower. Peas and potatoes for example are of no use to bees. Trees like sycamore have finished as have most hedgerow plants and lime does not flower until July. This is a time when we most rely on farms.

I have been able to get some farms to grow phacelia for me. This is a fantastic plant as it is easy to sow and establish, gets ploughed in as a ground improver and is easily sprayed off the following year if necessary. It helps us to cover our June nectar gap before the bees are taken to the heather. A study by INRA, a French laboratory specialising in beekeeping research, suggests that there is a link between protein nutrition and immunity in honeybees and that the more diverse the range of pollens the better the bees' immunity to disease.

The information above represents a few useful ways farmers can help without asking them to go to any expense or trouble. There are other ways they can help if they have an understanding of beekeepers' problems and to this end I have been successful in getting a grant of just over £50,000 for Scottish Bee Services Ltd to put together a project to highlight the ways in which farmers and beekeepers can work together. This will help beekeepers reduce disease problems by getting better nutrition in the hives by highlighting to farmers how they can help.

This will be done in a number of ways:

- Establish a database of farmers looking for hives
- Highlight different beneficial planting options for farmers
- Six farm walks will be held bringing together many different landowners to demonstrate the benefits of bees and what they can do to help.
- Establish six field scale demonstration sites with different pollen and nectar yielding plant varieties.

- Develop a web based presence backed up by literature giving information on bee related practice and links to appropriate knowledge bases, such as The Scottish Agriculture College.

There will be independent evaluation of the field trials. Projects, such as the field walks, are aimed at getting as many landowners as possible to understand how they can help and in return how bees and other pollinators can benefit their land. If this is successful then, through the Bee Farmers Association and other beekeeping bodies it can be rolled out across the country.

It is important to stress that this is not about turning the clock back to a time of wildflower meadows and low intensity agriculture. Farmers have an enormous challenge ahead to feed a growing world population. **However, given a better understanding of what bees need, they can make a few small adaptations to their farming practices** which would produce an enormous difference to our hive nutrition thereby reducing our disease problems and so improve pollination potential.

Bees on phacelia

CONCLUSIONS

The reduction in bee colonies in recent years has been a worldwide phenomenon but with no common link. Maintaining the health of our bees is central to our industry going forward.

In the UK we need to improve the following areas of beekeeping:

1. Disease control through better bio-security to stop the spread of disease between hives with better hive management and sterilising of equipment.

2. Improved nutrition by working with government agencies and landowners to improve the available forage for bees.

3. Better queen breeding and the use of AI to improve the genetic characteristics required to improve our stocks to help combat disease and improve honey yields.

4. More frequent re-queening of hives to ensure strong colonies.

RECOMMENDATIONS

For Beekeepers

1. Give the bees access to pollen substitute all the time so that they can access it during poor weather or periods of natural shortage.

2. Re-queen every year with your own stock or queens from a good queen breeder.

3. Select queens very carefully for the environment they have to work in.

4. More use of AI to breed healthy productive strains of bees.

5. Although beekeepers receive no direct subsidies there is funding out there if applied for.

6. Be prepared to work hard with government bodies for the benefit of the industry.

7. The beekeeping organisations need to have a more coordinated and professional approach when lobbying government. This requires a higher level of funding from individual beekeepers.

For Farmers

1. Lobby HGCA for recommendations on seed varieties that produce higher yields of nectar and pollen.

2. Try to leave a week or two between the sowing times of rape in different fields.

3. Keep your eyes on a trial by P J Stirling Ltd whereby bees are delivering fungicides and thus reduce the spraying need for botrytis.

4. Plant spring sown oil seed rape, borage, beans and especially phacelia to assist beekeepers.

5. If you have a local beekeeper talk to him and find out how you can help each other

continued overleaf

For Government Bodies

1. Direct less money into research and more into supporting existing and potential new beekeepers. The research is wasted if there are no beekeepers to benefit from it.

2. Establish apprenticeships and funding streams for new entrants into the industry.

3. Consider pollinator requirements during CAP reforms.

4. Apply for the EU funding available for beekeeping but not currently taken up by the UK government, thus putting UK beekeepers at a financial disadvantage from their European competitors.

THE NUFFIELD INFLUENCE ON MY BUSINESS

I should have entitled my application to Nuffield as 'How do you change the weather in Scotland in order to produce more honey'!

Like many areas of agriculture we can learn from other countries and improve our management but ultimately we need good weather to produce honey, something sadly lacking in Scotland in the last few years. There is a good future for beekeeping in the UK and demand and prices for honey have never been higher. In our short Scottish season we must manage our hives in order that they are ready to produce the maximum amount of honey as soon as the weather conditions are right.

I am already seeing some of the benefits this year (2011) from lessons learned during my Nuffield Scholarship.

- The use of 'Bee Feed' a pollen substitute to maintain nutrition during poor spells of weather.
- Importing more queens from NZ with the ultimate goal of carrying out our own queen breeding in Portugal.
- I am the first Chairman of the newly formed Scottish Bee Services Ltd which is designing and building and running the first sterilising plant in the UK. A grant has been received from the Scottish government to do this.
- A pollination awareness project to work with farmers to see how we can help each other.

ACKNOWLEDGMENTS and THANKS

I must thank my wife, Edel, her parents and my parents for keeping life going at home with our four children while I was away. It was a lot of work for Edel to look after four young children as well as keeping her own business running.

Thanks must also go to my staff for keeping things running in my absence, especially Susan who made sure there wasn't an enormous backlog of office work awaiting my return.

I would like to thank my sponsors Alan and Anne Beckett for choosing me to be the first beekeeper in the UK to receive a Nuffield Scholarship and I hope that this report will be the first of many.

I also thank John Stones and the Nuffield organisation for helping me through a most enjoyable process.

My travels would not have been as productive without the help of the people and companies I visited overseas. Special thanks must go to Paul and Desiree Koch in Western Australia and Ben and Jo Hooper in South Australia who put me up for so long. In New Zealand I especially thank Russell and Annette Berry for contacting and lining up a diverse range of operations to see as I travelled through the country, ensuring I had a unique insight into the industry.

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GLOSSARY

American Foulbrood: Contagious disease of bee larvae caused by *Bacillus* spores.

Botrytis: Grey mould or fruit rot caused by a fungus

Breeder Queens: Usually artificially inseminated queens used to keep breeding lines pure.

Brood Boxes: The area of the hive where the brood is reared; usually the lowermost hive box.

Brood: Immature or developing stages of bees, includes eggs, larvae and pupae.

European Foulbrood: Brood disease of bees caused by *Streptococcus* bacteria which infects the gut of the developing larvae.

Extraction Plant: Machines that are required to remove the honey from the frames.

Feral Bees: Those not managed by beekeepers.

Frame: Rectangular wooden frame designed to support the wax honeycomb.

Larvae: Stage in life of bee between egg and pupa- grub stage.

Nucleus: A small colony of bees usually resulting from a colony division.

Package Bees: A quantity of bees (1-1.5Kg) with or without a queen shipped in a wood and mesh cage to start or boost colonies.

Queen Cells: A cell in which a new queen develops.

Queen: Sexually developed female bee. The mother of all bees in the colony.

Varroa: ***V****arroa Destructor* is an external parasitic mite that lives on the back of the honey bees. In winter it feeds off the bee's blood and in the summer gets into the developing brood cells and reproduces. It is also responsible for passing diseases and viruses around the colony.

Virgin Queen: An unmated queen.