AUSTRALIAN NUFFIELD FARMING
SCHOLARS ASSOCIATION

SUBJECT:
SEED CLEANING, DRYING AND STORAGE

BY

ROBERT DENT

1999 AUSTRALIAN
NUFFIELD FARMING SCHOLAR

Sponsored by Qantas Airways Limited,
Impact Fertilisers Pty Ltd and
Department of Primary Industries, Water and Environment (Tasmania)

1. INTRODUCTION

The main topic of my study was the cleaning, drying and storage of seed. Although I aimed to look at most seed, my particular interest was grass seed. To study this topic however, it became necessary to split the scholarship into two parts:

(1) The tour organised by the Nuffield Association from mid-February to the end of March.
(2) My own study where I left in mid-June and returned mid-November.

This allowed me to mainly study seed drying in the United Kingdom where I could see the first of the crops come in to be dried as well as attend Cereals 2000 and some of the Shows (including the Royal Show) where many companies exhibit machinery associated with seed cleaning, drying and storage. Later in the year also suited most of my contacts in the United States of America and Canada.

1. ACKNOWLEDGEMENTS

Firstly, I would like to thank the Australian Nuffield Farming Scholarship Foundation for giving me the opportunity to travel overseas and see first hand seed cleaning, drying and storage systems and agriculture in general from around the world. Today more than ever information is becoming easier to get from the wide array of books, magazines and now the internet. No matter how good this information is however, it cannot replace actually seeing what is being done successfully in the industry. For ideas to work they must be practical, economic and working in a commercial situation. It is from this point of view that the Nuffield Scholarship is so valuable.

I would like to sincerely thank the sponsors Qantas, Impact Fertilisers and the Tasmanian State Government for their generous support which makes a long trip such as this possible.

While I was away several people played an important role in running the farm and cleaning plant including my wife Jane, father Bill, Don Peterson and Stuart Smith. Their work and dedication over and above what is normally expected is greatly appreciated with everything running smoothly while I was away.

To all those people I stayed with and to everyone I visited that shared information so freely I am sincerely grateful (see Appendix).

Finally, to Don Walker Nuffield Scholar (1972) who was my inspiration for going for a Nuffield Scholarship.

1. ORGANISED TOUR

This part of the Scholarship organised by the Nuffield Foundation looked at many aspects of agriculture from the practical, agri-industry, ag-research and agri-political points of view without looking at any particular industry. The tour visited Singapore, Malaysia and Thailand in Asia, followed by the United Kingdom (including London and west of England based at Cirencester), Belgium (Brussels) and France (Toulouse) in Europe.

This, coupled with my time in Oregon and Alberta in North America gave me a good insight into general trends that are occurring in agriculture around the world.

Everywhere I travelled agriculture in general was struggling due to low world commodity prices, even countries with agricultural subsidies. This was especially so in the United Kingdom as subsidies were changing to be more environmentally related. In Brussels the term "multifunctionality" was frequently used which simply means that farmers are paid for benefits they bring to society rather than for their production, eg paying to make the countryside look good for people in the city. Environmental considerations seem to be playing a much greater role to the point where supermarkets are dictating to farmers how they perceive consumers want their food to be produced.

In the United States and Canada, low commodity prices were also hurting farmers. This had prompted one farmer to start a scheme "Focus on Sabbatical" where participating farmers would be paid for leaving fields unplanted. Payments would come from an investment company set up and supported by producers. This was starting in Canada and the United States but were also looking at other countries such as Australia. By taking land out of production they were hoping to increase prices, much like the set aside scheme in Europe but this would not be government run.

As Tasmania finds it difficult to compete in commodity markets I took particular interest in how farmers were getting around low prices. There was a constant them over the whole trip which was best stated by one UK farmer "If the consumer won't pay more (and they usually won't) you either:

(1) Increase efficiency; or
(2) Shorten the supply chain.

A third alternative was stated by other farmers

(3) Produce alternatives to commodity produce.

In the past farmers have increased efficiency, eg by economies of scale, better farm practices, better varieties, etc. Although not exhausted the opportunities are becoming increasingly limited. One opportunity to increase efficiency is through genetically modified organisms (GMO's) which offer a real possibility of increased efficiencies through less sprays and better varieties. This was starting to be seen in the US and Canada.

The farms that appeared to be doing better than others however had taken the second or third option, ie shortening the supply chain or finding alternatives. This was frequently done by direct selling or value adding their own produce (and others as well) or both.

Some of the examples include:

(1) Farmers' markets, where farmers would bring their produce to a central location for sale. This was particularly seen in the UK and Thailand.
(2) The dairy industry by
    (a) processing and delivering their own milk;
    (b) icecream making (explained to me as essentially selling air!);
    (c) cheese making;
    (d) yoghurt making.
(3) Seed industry by
    (a) particularly in the US and Canada farmers were processing and packaging their own seed and marketing it themselves; or
    (b) forming farmer groups to market it.
(4) Organic, those doing best seemed to have their own shop with a loyal clientele.
(5) Farm shops, there seemed to be many in the UK exploiting the fact that with the many food scares in Britain, BSE, etc, by buying direct there seemed to be a greater acceptance by consumers of the safety of the food.
(6) Farm tourism saw various ways from farm cottages, camp grounds, bed and breakfast, etc.
(7) Oilseed processing, processing and marketing a range of oils, eg borage, hemp, sunflower, etc.
(8) Hay market in Canada processing and exporting Timothy hay.

The difficulty in either accepting commodity prices or doing any of the above appeared in many cases to be putting great pressure on the family farm in all countries I visited.

One totally different alternative I visited was a Hutterite community in Canada. Here most of the profits go back to the farm with the community (up to 100 people) live a very frugal existence. These communities had the latest equipment and were buying up farms. As they were taking little for themselves they could effectively produce commodities cheaper than anyone else.

1. OWN STUDY - SEED CLEANING, DRYING AND STORAGE

INTRODUCTION

In order to study anything overseas a comparison needs to be made with the situation at home. In this case it is seed cleaning, drying and storage in Tasmania. Alternatives therefore found overseas will be compared to the following description.

Tasmania has a cool temperate climate and is ideally suited to most temperate seed crops. Harvesting of most crops occurs from December to March. Although, Tasmania generally has a winter dominant rainfall, unseasonal rain frequently occurs over the harvest period. As more seed is grown there is an increasing demand for seed to be dried. At present there are only a small number of driers in the state with only one or two able to dry grass seed.

At present there are only four main cleaners that can clean most crops, with a small number set up to do specific crops. As the seed industry has diversified to a number of crops coupled with the small number of cleaners, each plant must be able to clean a variety of seeds ranging from poppy seed to large white lupins. The general configuration of cleaners is:

(1) Pit for raw seed;
(2) Pre-cleaner to take out larger straw and some light material.
(3) Air-screen machine - separates by width and lightness of seed.
(4) Indented cylinders - separates by length of seed.
(5) Other machines depending on seed to be cleaned, eg gravity table separates by specific gravity, spirals separate by ability of seed to roll.
(6) Bagging bin with semi-automatic weighing and manual stitching and palletising.

There is very little on-farm storage, especially amongst seed growers. Consequently, seed cleaners need to store virtually all the seed straight off the header. As many lines of seed are small in Tasmania considerable segregation is needed. At present this is mainly achieved by cone bottom silos, some bulk bays and boxes or bulka bags for small lines.

At the end of each section which described what I found to be the normal practices I have included an alternatives section where usually only one or two people were doing something different which would benefit the Tasmanian industry.

SEED CLEANING

My main interest in this area apart from looking at the latest machinery was to look at the configuration of cleaning plants and how they were set up to clean a range of seeds.

To look at some of the latest machinery I visited the Westrup plant in Slagelse, Denmark. Although organised early in my tour, the majority of cleaning plants I visited had Danish machinery, either Westrup or Cimbria.

The basic principles of cleaning seed have changed little over the years, particularly with respect to the main part of the plant, the air/screen machine. The biggest trend was to larger machines, and to more computer control of settings. This also allowed for pre-settings for particular crops although final settings would still need to be done by eye.

UK AND DENMARK

In the UK, a few farms I visited had their own cleaners, however, they were usually simply air screen machines to pre-clean the crop with the final cleaning done at a specialised cleaning plant.

Most full cleaning plants tended to be fairly large, often with several cleaning lines and tended to clean a relatively narrow range of crops. However, few had large inward storage infrastructure as seed was mostly stored on farm until it was needed by the cleaner.

The configuration of these plants was similar to that in Tasmania (as outlined in the introduction) with the main exception being that most had some form of automatic bagging and palletising machinery. There was also a trend to use _ tonne bulka bags for cleaned seed and most plants could fill them using semi-automatic systems.

Machinery in the majority of cases was elevated so you could walk under it although generally bucket elevators were used between machines rather than gravity fed. This effectively cut the height of sheds down.

With grass seed, although sometimes bagged, this was frequently put into boxes as most of the pasture and turf seeds were blended at a later stage. Most plants that cleaned grass seed had blending facilities.

Seed treating was usually done in the line with just a diversion into the treater before packaging.

The situation in Denmark appeared similar to the UK with a small number of larger plants with fully automated weighing, packaging and palletising machinery.

MOBILE SEED CLEANERS

Mobile cleaners were used extensively in the UK. Farmers were allowed to sow their own seed of protected varieties provided they paid a royalty which was usually collected by the cleaner operator.

Cleaners were all relatively similar with all the machinery on the back of a flat bed truck or occasionally on a semi-trailer. They consisted of an auger feeding from the farmer's silo or trailer into a small holding bin then elevated by bucket elevator into an air screen machine or occasionally a rotary screen. From here it was elevated into gravity separator (see alternatives section) which separated cracked and deformed grain and light impurities not taken out by the air screen machine. Seed could then be elevated by bucket elevator and drop through a seed treater and into either a bagger or batch weigher and direct into a truck or bulka bag.

These machines, although not suitable for small seeds, did quite a good job on coarse grains for which they were designed. They were quick to clean down and change lines and as they were run off a small generator pulled behind the truck, they could be set up anywhere.

OREGON, USA

WILLAMETTE VALLEY

This area is one of the largest grass seed growing areas in the world, particularly ryegrass seed.

Most farms tended to be relatively large with their own cleaning plants. They sometimes cleaned smaller neighbour's crops although the main use was to clean their own.

Seed companies often did not have any cleaning machines or if they did they only cleaned a small proportion of seed sold. Seed companies however, frequently had their own blending facilities. This was particularly seen at Barenbrug where a large blending, packaging and distribution centre was recently put in, with no cleaners at all. They simply buy cleaned and tested seed straight from the farmer. Often this was grown under contract.

The configuration of plants was similar in order to that outlined in the introduction with the main exception being that nearly all used carter discs rather then indented cylinders to lift the grass seed. Cylinders were still generally used to lift shorter seeds out of the grass seed. Most cleaners claimed carter discs lifted grass seed better than cylinders.

Most plants had used height with usually four levels of machinery, with seed gravity fed between machines thus using less bucket elevators. This appeared harder to clean down between lines although they tended to have large lines and therefore needed fewer clean downs.

Unlike the UK and Denmark most plants had manual packaging and palletising.

MADRAS

Although only a short distance across the Cascade Mountains from the Willamette Valley there was considerable difference. Here mostly Kentucky Bluegrass, annual bluegrass or carrot seed was grown. With smaller farms, seed companies not farmers owned the cleaning plants. Plants also tended to be smaller with most machinery on one or at most two levels more like the Tasmanian situation.

As with the Willamette Valley however, carter discs were almost universally used to lift the grass seed.

CANADA

The main reason for travelling to Canada was to look at cleaning and handling of canola where I concentrated mainly in Alberta and western Saskatchewan. Here there was a larger combination of cleaner ownership. Mainly cleaning plants were municipal plants run usually by a co-operative of farmers with government assistance initially to set them up. These varied considerably how they were run. Most tended to be older plants that in some cases had been modernised. Nearly all were multi-tiered plants generally only cleaning cereal seed.

Some farmers also had plants associated with their farms and it was these I concentrated on.

Almost without exception the configuration of the plants was the reverse of the standard with indented cylinders being before the air screen machine with a pre-cleaner mounted directly on top of the cylinders. When asked why the usual answer was “We’ve always done it this way.” As they were mainly cleaning cereals and as canola does not rely greatly on cylinder separation the main work was being done by the air screen machine and hence cylinders were being used essentially as a pre-cleaner, mainly removing cracked and broken grain. This system appeared to work quite well. When canola was cleaned spiral separators were always used. Usually six pairs were used per tonne of canola.

Again, as with Oregon, manual packaging and palletising was used although most cereals are now cleaned into bulk storage and then later bulk into trucks.

This also allowed treating of seed to be done in an area separate to the cleaning plant. Even when seed was bagged in the plant the actual treating was frequently done in a separate room. This effectively isolated people working on the cleaners from chemical.

ALTERNATIVE CLEANING METHODS

GRAVITY SEPARATOR

I had not come across this machine before and only saw it on mobile plants in the UK. The only brand was a Sangatti from Italy although on one mobile cleaner a homemade version was used. This machine was described in the brochure as simultaneously a dry stoner and a grain classifier.

The machine consists of two screen decks enclosed in a vacuum chamber. The upper deck has three sieve sections having different size openings. The decks have an oscillating movement driven by two vibrating motor drives. As air moves up through the screens stratification of the products by gravity occurs allowing the light fraction to float over the top screen. The bottom screen acts like a standard de stoner separating heavy particles like stones from the main product.

Although I did not see any of these units in a conventional plant they could prove very effective at the end of a line. On a few plants I visited an aspirator was used at the end of a line to take the last of the dust and light seed out. The gravity separator would be a better option giving even better separation and in many cases reducing the need for a gravity table. As it is small in size with a large capacity and easy to set up and clean down it could be used for most cleaning jobs giving a very high final standard.

FLEXIBLE CLEANING SYSTEM

With most cleaning plants I visited the machinery was either on several levels or at least on one level so you could walk underneath it. On a small number of plants at least the main air screen machine was at ground level, just high enough to drop seed onto a conveyor and into a bucket elevator. This made it easy to observe the machine. This method was particularly used in smaller plants that tended to clean a range of seeds. At one plant I visited the air screen machine was the only machine fixed into position, all other machines, including the indented cylinders, were on wheels. Only those machines needed were in the cleaning line, anything else was wheeled out of the way, thus making the line easy to clean down and as everything is at floor level each machine is easy to observe. This made the plant very versatile in what they could clean.

COMBINATION AUGER/BELT ELEVATOR

In Denmark one cleaning plant was using boxes for inward storage of seed. To fill the boxes raw seed was tipped into a pit. In the bottom of the pit was a belt elevator that dumped into a bucket elevator which elevated the seed to fill the boxes. On top of the belt there were two augers. These moved light material, eg some grass seeds, and the belt ensured that the bottom of the pit cleaned out totally. The combination of belt and augers gave the advantages of both, the ability to handle light seed and 100% clean down.

This configuration is also now available as an option for the feed of Westrup cleaners.

SEED STORAGE

My aim with seed storage was to look at ways of storing uncleaned seed (inward) and cleaned seed (outward).

UK & DENMARK

I have included these countries together as I only visited two cleaning plants in Denmark and these were very similar to the UK.

Inward storage at cleaners was not a huge problem due to:

(1) Nearly all grass seed needed to be dried which was usually done on drying floors in bays which also acted as storage. All this was done on farm.

(2) Many farms had a large quantity of flat floored sheds which were used for animal housing in winter. These could be used for storing seed at least until next winter by simply piling seed up, sometimes with wooden barriers between. If seed needed to be dried it was simply moved from the drier or the floor converted to a drier using a series of above floor ducts. As nearly all farms had telescopic loaders, seed was loaded into trucks with these.

Cleaners therefore accepted seed for cleaning when they wanted it and hence needed very little storage, particularly for grass seed.

USA, OREGON

Williamette Valley

Most farms I visited had their own seed cleaner. Much of the seed produced was VNS (variety not stated) and hence large lots could be cleaned in a single lot. Seed was frequently just left outside piled up in a cone shape. Provided it was kept this way I was told moisture would not enter the heap far or if some did it simply added to the weight of the seed!

For certified seed either silos were used or more frequently large flat walled bays were used where seed was simply dumped in with trucks and piled up with a loader. At one relatively new plant I visited, the cleaner was located in the middle with a long row of bays each side. Seed was then taken out of the bays using a small Kubota loader and dumped in a small pit in front of the cleaner where the seed was elevated to a holding tank above the main cleaner. Large eaves protruding out from the shed prevented rain coming in and provided a covered area in front of the shed to run the loader if it was raining. No doors were on the bays.

Outward seed was mostly stored directly in bags straight off the cleaner and stored in a large warehouse.

Madras

In the Madras area, the other side of the Cascade Mountains from the Willamette Valley, a different system of storage was used. This area was described as a highland desert with farming only possible with irrigation. Here farms tended to be small with very little storage and hence seed was taken directly to the cleaners off header. Virtually no one had their own cleaner. The seed grown was mainly Kentucky Bluegrass, annual Bluegrass or carrot seed.

As most lines of seed were smaller than in the Willamette Valley, instead of large open bays, smaller closed bays were used with seed blown in using suction/blowers directly from trucks or via a pit. Bays were usually aligned either side of an alley with the front of the bays having removable sections. When seed was to be taken out the bottom section was removed releasing some of the pressure followed by higher sections. Seed was carted to the cleaner using a bobcat or a bucket on the front of a forklift.

Bays were made of wood and lined with fibreboard. This system therefore provided a large number of small storage bays in a relatively compact space. This system, although worked well, was relatively expensive to set up and was very noisy and dusty during filling.

Outward seed was mostly stored directly in bags straight off the cleaner and stored in a large warehouse.

CANADA

Here I looked mainly at canola seed. In nearly all cases canola was stored in either flat or cone bottom silos and sometimes this was stored on farm although most seed cleaners had considerable storage. This was due to the fact that seed was cleaned back into silos so that it could be tested and then pickled just prior to sowing the next year (spring). For ease of cleaning out solid smooth walled steel silos were used even though more expensive then conventional galvanised iron silos. Seed was transported to the cleaner by augering into a trailer or truck bin and then augering into a holding bin which fed the cleaner. The reason for this rather than direct feeding is due to 1) silos are used for inward and outward seed and hence needs to go to a different place in the plant and 2) if conveyors were used its easy to pull the wrong chute whereas if it purposefully has to be put in a trailer there are more opportunities to correct mistakes.

On many storages particularly with canola, temperature probes were installed in silos that measured temperature at various levels. A monitor owned by the farmer or frequently field officer could then be attached and any problems determined quickly.

ALTERNATIVE STORAGE METHODS

All the above methods of inward and outward storage tend to be used for only one or two lines of seed and are fairly inflexible when many different lines and sizes of lines are involved. While all the above storage methods worked well to varying degrees, I was looking for flexibility and ease of cleaning out to allow varying lot sizes and types of seed. Cost is also a significant factor as any form of storage is expensive.

COLLAPSIBLE WOODEN BOXES

These were made of plywood with spring metal clips holding everything together. These were relatively cheap and as everything was held firmly together, this kept the box straight with relatively light material. The box could be emptied using conventional box tippers either stationary or on a forklift. When the box was empty a small hand tool was used to flip the spring clips out and the walls, lid and base would all come apart. Everything would then stack down into a flat pack, again held together by the spring clips.

These had many advantages particularly for outward storage but could also be used for smaller inward lines. As they come apart, no seed gets caught in the corners to contaminate the next line, and their design makes then relatively cheap compared with solid wood or steel boxes which are frequently used. They also do not take up much space. This system was being used successfully by Countrywide Farmers in Worcestershire.

FLAT SIDED BULKA BAGS

Conventional bulka bags become rounded and are difficult to stack even on pallets more than two high. Even then they tend to lean or fall over. Two places, Church Seed in UK and Don Coon in Oregon, were using relatively flat sided bulka bags. These were approximately 5’ x 4’ (standard seed pallet), with gussets across the corners on the inside keeping the walls relatively flat and tight. These could then be stacked at least three high without leaning. At Coons they had stencilled on the bags the species of seed and these bags were then only used for that species for the life of the bag thus reducing contamination risk. This provided relatively cheap storage particularly for outward storage but could also be used for inward storage. When finished they take up even less room then the boxes. Coupled with automated or semi-automated filling mechanisms they provided a very useful and cheap form of storage.

SHED ROOM

Shed room for either boxes or bulka bags is always a problem, especially as frequently only short term storage is needed and does not warrant the expense and often over-capitalisation of a large warehouse. This can possibly be overcome by fabric sheds originating from Canada. I also saw these in the UK. At about one-third the cost of a conventional shed (or claimed by the maker) this becomes a relatively attractive option. They are quick to erect and equally dismantle and sell if no longer required. For temporary storage this could be placed on the gravel or screenings. Used in conjunction with boxes or bulka bags this forms a cheaper and effective way of storing seed.

These were also being used for bunker type grain storage by building a concrete floor and walls with the shed on top which would be ideal for large seed lots. The ends can fold down to seal birds out so could be used for human consumption grade seeds such as linseed.

USED SHIPPING CONTAINERS

I had been looking at the proposal for a while using shipping containers to store and transport seed. It wasn't until the last person I visited in Canada, Dory Tuvim, who was using shipping containers to store seed and grain.

Dory is not in the seed business but had moved to Alberta to semi-retire and recognised the possibility for seed and grain. He owns a container repair and modification business in Toronto …

Containers are relatively cheap, readily available, sealed from vermin, etc and when tipped empty out completely or you can easily walk in and clean them out. The container would also be used for drying seed (see drying of …) making it very versatile and a good size for storing a large variety of seed.

Dory transported them in two ways:

(1) Empty containers were transported on a tilt trailer he built himself which would carry two containers and pulled by his small truck via a goose-neck to the tray. He could then tip them in the field to be loaded directly from the header.
(2) To transport the filled containers he bought an old container side loader from the railways and lifted the container on to a truck. The side loader was too heavy to transport a full container by itself. It's for this reason he bought it cheap.

The main aim was to have seed cleaning plants have the handling equipment with many truck companies able to transport the containers.

This method has considerable merit with the main downfall being the initial investment in handling machinery. According to Dory in Canada secondhand machinery is readily available and has been round long enough to get good machinery. This would need to be investigated in Australia.

SEED DRYING

The main reason for going to the UK was to look at seed drying. It soon became apparent that grass seed was the most difficult to dry and any system that could dry grass seed would dry grain but most systems designed for grain would not dry grass seed. For this reason I concentrated on ways to dry grass seed.

Although some commercial driers claimed to be able to dry grass seed most manufacturers agreed that particularly at higher moisture contents grass seed would not flow well and therefore would cause problems. Virtually all stated that flat floor drying was the best way to dry grass seed.

CURRENT PRACTICES

SYSTEMS OF DRYING

Tunnel with laterals

This is one of the older methods but still used extensively. This consists of a plenum chamber with lateral vents situated on the concrete. They were usually filled with a loader so as not to pack the seed down. The seed was also removed with a loader, removing the laterals as you went although frequently damaging them. These could be used on most floors, eg modified stock pens.

Flat drive on floors

These consisted of either on-floor ducts or on-floor wooden panels forming a flat floor with aeration channels. Some consisted of channels in concrete with cross channels also in the concrete. These systems were very versatile as there were no ducts to hit with the loader when emptying. Seed could be dumped on the floor directly from the truck or trailer and the shed could be used to store machinery or bagged seed on pallets, etc. The air was fed from a plenum chamber either between the bays or across the back. A slight variation was the Scottish tray system which consisted of three bays with false floors you could drive on and a plenum chamber across the back. Air was fed usually from both ends of the plenum chamber so you could use one, two or all three chambers.

The above systems were the most common I saw and nearly all new flat floor driers were like this.

The main downfall with these systems for grass seed was that it could only be filled to about 4' maximum. Any more and moisture would condense before it got out of the pile.

METHOD OF DRYING

Almost universally large fans, gas or occasionally oil fired heaters were used. The heaters were linked to both temperature and humidity controllers in the plenum chamber which regulated the amount of heat applied. This protected the seed from getting too hot or prevented the use of heat when atmospheric conditions were acceptable.

Thirteen years ago I had been in the UK on a Young Farmers Exchange and noted that dehumidifiers were being used which seemed ideal to use with seed. I didn't see any in use this time however. I was told that the gas heaters were much cheaper and with better humidity and temperature sensors there was no need for dehumidifiers.

Although gas heaters were generally used, in some areas, particularly Scotland, oil fired heaters were used with the same sensors as gas fired heaters. The decision seemed mainly one of cost although gas is a cleaner flame and is preferred over oil where seed is used for human consumption purposes.

In Canada and Denmark hot water was frequently used with heat exchangers in front of the main fan. Although this system is less efficient, in these countries, hot water was readily available as this was used to heat houses, sheds, etc. This method also allowed a variety of fuel sources, eg wood, straw, etc, to be used.

All the above methods use the simple rule of thumb that increasing the temperature of air of 100% relative humidity, (RH) by 6^{o}C will lower RH to 65%. The other rule of thumb used with respect to air volume was 0.05 m^3/s/Tonne for 24 hours will reduce moisture by 0.5%. Although several factors affect the above rules of thumb, over most instances they are a fair guide.

Many farmers told me that simply the more air you can get through the better and that the best device for measuring the flow of air is a handkerchief placed flat on the seed should just rise up off the seed if sufficient air is flowing through.

SEED AERATION

Aeration is the process where small volumes of air are passed through seed to reduce temperature and prevent deterioration. Aeration is particularly useful for seed placed in piles or silos waiting to be dried and for seed stored at close to or just above maximum storage moisture contents. As only low volumes of air are used very little drying takes place although given the right ambient conditions and long enough time some drying will occur and this may be enough to make the seed safe for longer term storage.

Although there are many forms of aeration, the main area I looked at was aeration of on floor piles of seed or seed in bays as this was the main form of seed storage for grass seed.

In many instances aeration was achieved using the same systems as for drying. In the absence of this, either pile-dry pedestals or wide piped ducts on floor were used.

Pile dry pedestals are vertical columns perforated in the bottom half which was also a larger diameter with a 6" non-perforated pipe protruding out the top of the heap. These are free standing and placed wide enough apart to get a loader through. A small fan was placed on top of one or more of the pedestals which sucked air out. Low volumes of air were then sucked through the seed and out the pedestal. The small fan was easily shifted to other pedestals making it a relatively cheap method of aeration. Pedestals were made either of steel or large diameter plastic drainage pipe.

Drainage pipe was also used on floor with the same small fans sucking air out. Again, the pipes were wide enough apart to get a loader through.

The other method was drying spears which were a perforated tube with a short auger on the end which could be screwed into problem hot spot areas of the pile. Again, a small fan was used to suck air out. Many farmers had these for emergency use to cool an area if something went wrong. I also saw these used in boxes and bulka bags when these heated.

ALTERNATIVE DRYING METHODS

STIRRERS

One of the major problems of drying grass seed in flat floor driers is that seed can only be piled about 4' high. Due to the resistance of flow of the grass seed, any higher and moisture will condense in the upper layers of seed.

Stirrers can be fitted to existing bulk on-floor driers. They consist of two tracks on either side of the bay with a boom across the bay attached to the tracks. On the boom are two auger carriages each with two auger flights which hang down to the floor of the bay. The variable pitch augers move the seed from the bottom to the top of the pile. At the same time the auger carriages move from side to side on the beam and the beam moves along the tracks on either side of the bay. Thus effectively the whole bin is stirred.

This effectively allows you to dry seed at greater depths and more uniformly. Stirring also reduces crop density and resistance to airflow resulting in an increased drying rate.

TRAILER DRIERS

Trailer driers are simply an extension of the use of stirrers. I saw two different versions:

(1) A commercial model with everything mounted on the trailer permanently including fan, heater, stirrers and false floor; and
(2) In Scotland a company was making kits to adapt to existing trailers with a detachable stirrer and false floor and an external fan heater and ducting to the trailer.

Both these were ideal for grass seed drying. They could be quickly filled from a bulk store with a loader or filled directly from the header and emptied quickly simply by tipping the trailer. The trailer also empties completely even with seed that has fallen through the false floor. This system is therefore ideal for drying many different seed lines. The same principle could also be applied to open top shipping containers as outlined earlier for alternative storage. Although permanently fixed to trailers, these were apparently used in Denmark on some farms.

5. CONCLUSIONS

Although not part of this report, I also investigated opportunities for Tasmania in the seed industry. As highlighted in the organised tour section farmers around the world are looking for alternatives to commodity production. The seed industry offers increased prospects for Tasmanian farmers. There are many opportunities especially with respect to contra seed production where seed from northern hemisphere countries is shipped south to grow a second crop in the same year. To do this and get the best yields and quality you need to get far enough south with a late season and similar growing conditions to the main northern hemisphere countries. There are relatively few areas in the world suitable. These include parts of Argentina and Chile in South America, part of the south island of New Zealand and Tasmania and southern Victoria in Australia. This puts Tasmania in a very good position on a world scale.

This is especially the case with genetically modified (GM) crops as new varieties can be created quickly but still need to multiplied in the conventional manner. Contra production can halve the time to get a new variety on to the market. This has occurred in Tasmania with canola seed production in trial quantities over the past two years.

At the moment however, there is a moratorium on growing GM crops set by the Tasmanian State Government to determine the implications of growing GM crops in Tasmania. From what I have found on this tour, Tasmania has much to gain, particularly in the seed industry by the use of GM crops.

Regardless of whether GM crops are introduced or not the Tasmanian seed industry has been expanding over the last few years. To remain a reliable supplier of seed, major improvements are needed in seed cleaning, drying and storage capacity.

Except for the Madras area in Oregon much of the infrastructure needed is spread between farmers and seed processors in the main seed areas I visited. This is not the case in Tasmania with smaller farms and shorter history of seed production, infrastructure has been concentrated in a relatively few number of cleaning plants. This is especially so with seed drying which is essential to be a reliable supplier of seed in the unpredictable Tasmanian climate.

The seed cleaning plants already in Tasmania have considerable scope for expansion. In this respect I have highlighted a variety of methods of seed cleaning, drying and storage that are in current use overseas as well as many alternatives not yet in mainstream use but may have possibilities in the specific Tasmanian situation. Many of these ideas I intend to use in my own seed cleaning plant.

The Madras area of Oregon, USA has developed much like the Tasmanian industry of concentrated cleaning, drying and storage. As with there, it is unlikely that there will be a great increase in drying and storage by farmers. It is therefore up to the cleaning plants to increase capacity and introduce drying facilities as the seed industry continues to expand.

Appendix

EUROPE

Phillip & Ailsa Abbott, Seckington
Michael Caton, Rekord Farm Machinery
James Hollingsworth, JCB Landpower Ltd
Dr Peter Hutley-Bull, Farm Crop Rotations Limited
John Wells, Burbage Farms Limited
David & Christine Hill, Shipdham
Simon Wombwell, Monsanto UK
Robert Church, Church of Bures, Bures
Robert Salmon, Dereham
John Keer, Elsoms Seeds
Jim Orson, Morley Research Centre
David & Shirley Pollard
Arnold Peacock, Prickwillow
David Harrison Aldreth
Charlie & Bill Whitehouse, Ross-on-Wye
Peter & Helen Clutterbuck, The Lea
Diane & Fred Cross
Heals Limited, Latteridge
Kevin & Lynwen Green, Ferryside
Malcolm James, Countrywide Farmers Defford
Neville Bark, Germinal Holdings Ltd
Dick Bowler, Re-So Seeds Ltd
Richard & Louise Price, Longformarcus
Ian & Carole Brunton, Carnbee
David Harper, Averon Engineering
Matthew & Alison Burbury
Claus Bruun-Simonsen, Westrup
Niels Peterson, Kongskilde

USA

Rose & Bob Heery, Gresham
Don & Maryanne Wirth, Tangent
Terry Burr, Barenbrug USA
Forbes Seed & Grain Inc
Gary Frum, Plainview Seed
Kevin McVeigh, Willamette Valley Plant Breeders Inc
Donald Coon, Oak Park Farms Inc
Claus Sass, Jenks Seed Connection
Mashall Peters, Jenks Seed Connection
William Young, Oregon State University
Paul Zehr, Smith Seed Services
George & Cheryl Pugh, Shedd
Les Gilmore, Cenex Harvest States
Martin & Nancy Richards, Madras
Oregon State University research Centre, Madras
Sean Vibbert, Madras
Olsen Seeds
Central Oregon Seeds
Francie & Hal Kibbey

CANADA

Kevin & Jackie McKnight, Aventis, Lethbridge
Gordon Bussey, Bussey Seed Farms Ltd
Brian McNaughton
Enchant Seed Cleaning
Andrea Fox, Lloydminster
Ed & Cathy Anderson, Share All Farms Ltd Marwayne
Carl Veikle, Veikle Seeds, Cut Knife
Bill Snell, Lashburn Ag Venture Ltd, Lashburn
Agricore, Camrose