

Clever technology takes kiwifruit sorting to the next level

By John Bosch

During the 2004 season two kiwifruit postharvest facilities used optical grading equipment for the first time on a commercial scale in their industry. Later in that year the management of both Hume Pack-N-Cool and Seeka and praised the virtues of this equipment publicly in the local newspapers. During the 2005 season they were joined by the Apata group who invested in new sizing equipment to enable optical and infrared sorting of the Gold fruit. The question that can be asked here is "what has motivated the Boards of Directors of these organisations to increase their operating cost?" Assuming good stewardship, they must expect the investments to deliver a good return for their organisations. But why is this, and are there also benefits for the growers who pack with them? Further to this, will the broader kiwifruit industry benefit from the optical grading technology or is it just an added value feature for some highly specialized facilities? In trying to find an answer to these questions the above facilities were contacted.

The technology

Optical equipment comprises of cameras and computer software to interpret multiple pictures of the surface of the fruit. One of the first applications of this technology (about 15 – 20 years ago) was focused on colour grading. Colour grading is used in the apple industry where grade standards are based on the balance of colours seen on an apple, for example the proportion of red flesh over a green background. Typical

colour systems are only capable of measuring average colour and accumulated surface areas.

Recent technical advances made in camera technology and image processing broadened the scope of potential application in the produce industry. High-speed processing and high resolution digital cameras now enable packhouse managers to automate the grading process with image analysis examining a fruit's surface and shape. This application is called "blemish grading".

"Optical" light used by the equipment is roughly the radiation visible to our eyes. However, visible light is just a tiny portion of the electromagnetic spectrum which – to mention a few – also comprises of gamma-rays, X-rays, ultraviolet, infrared and radio. Apata also used infrared cameras to make images of the fruit (this application is different from the Near Infrared (NIR) technology which helps to measure dry matter of the fruit). Infrared does not detect colour and therefore it is displayed as a black and white photo of the fruit. It is used by Apata to compliment the information from the optical equipment.

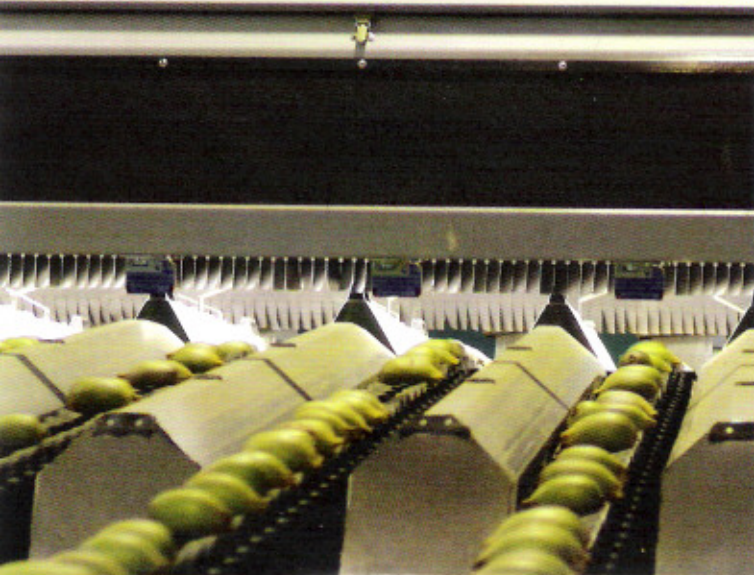
The optical and infrared equipment is supplied by Compac Sorting Equipment Ltd in Auckland. Their InVision9000iR system uses digital technology. Analog technology records (light) waves in its original form, however digital technology samples waves at some interval and then turns this into numbers that are stored in the digital device. Digital technology has the advantage that recording does not degrade over time and data can be compressed and analyzed at high speed.

Infrared technology has been used for many years as it can identify the edge of the fruit very well, therefore calculate the diameter of the fruit exactly. Apata trialed this technology on Zespri Gold fruit and observed that the equipment was also useful in detecting harvest puncture marks on the fruit.

Blemish grading – how does it work?

Blemish grading may be new to the kiwifruit industry but is widely used in many parts of the world on fruit like oranges, lemons, mandarins, apples, pomegranates and – just recently – on potatoes. Blemish grading of kiwifruit and apples has been in commercial production in New Zealand since the 2004 season. To date Compac has over 260 lanes of InVision Blemish technology operating worldwide. They share the global market for this kind of equipment with suppliers from

InVision
9000 Blemish



Pre-grading of Gold kiwifruit at Hume Pack-N-Cool, Katikati.



Europe but Compac sees their client base growing rapidly, including European installations.

For a packhouse to be able to blemish grade their fruit efficiently they need additional equipment. For instance, for the 2003 season and earlier, Seeka Transpack used a 6-lane sizer for Gold fruit with packing arms for each outlet. However to be able to use the technology they needed to install an additional 8-lane sizer (called a pre-sizer). When the fruit arrives on this pre-sizer the optical equipment enables the operator to select the fruit into different quality categories for blemishes detected on the fruit. The pre-sizer then delivers the fruit to the 12 sorting tables Seeka has. The fruit delivery happens extremely gently through brush rollers. As the pre-sizer has all the features of a normal sizer it can also redirect fruit of a particular size to any of the sorting tables. This particularly is a useful tool when eg, flat size 27 fruit is pushing the maximum tolerance level.

Not all the fruit tipped arrives on the sorting tables as undersized and oversized fruit and really misshapen or blemished fruit are directed to separate outlets from the pre-sizer. Excellent and very clean fruit, good grade fruit, obvious defects and the in-between fruit are submitted to separate tables. Excellent grade fruit does not need any graders. The

other sorting tables can have various numbers of grading staff dependant on the category of defects submitted to these tables.

Blemish grading is applied to Hayward Green (hereafter called "Green") and Gold fruit at Hume Pack-N-Cool and Apata and mainly to Gold by Seeka. Hume Pack-N-Cool and Seeka also use the blemish equipment to segregate the Green fruit into class 2 and 3 categories.

Generally speaking, the excellent or good quality of fruit that needed little attention was around 45%. Real reject fruit and undersized fruit was around 10%; this left 40% to 50% to be checked by the graders. Compac believe this will improve greatly next season.

Operating the InVision system does not require a science degree; however computer knowledge and knowledge of the grading standards are important. The software comes with a click & learn feature that helps to create a map of what are acceptable and not acceptable blemishes. The actual pictures of fruit "photographed" by the equipment can be called up on screen and the operator can click on the fruit and tell which fruit is good and which is not acceptable. The system can be up and running within an hour starting to map the fruit, however some effort is required to fine tune the system.

Although the packhouse staff in charge of the blemish grading are very positive about what they have achieved so far, it is fair to say that they are still gaining confidence with the technology. Compac has a strong commitment to further develop this application in the kiwifruit industry and now also has a couple of kiwifruit packhouses in Italy using the same equipment.

The benefits of optical and infrared grading

This paragraph deals with the advantages as experienced during the last two seasons. They are mentioned in no particular order of priority. The next paragraph is on the future potential of this technology.

Improved grading results

Apata CEO Stuart Weston comments: "As it was the first year of use for us, the system and our confidence developed. Less than half of the potential defects actually circumvented human decision points. This fruit accounts for only half of the real benefit realized: the key advantage for us was segregating the remaining fruit into different quality "sets" delivered to different grading tables. So for the higher quality sets, we needed a lower-capacity grader person (just looking for stalks or misreads) or no graders at all. The real advantage was in targeting our best graders on the lower quality (marginal fruit) sets. This meant we were able to optimize the use of the human grader capacity we had available – bearing in mind that the job of a grader requires an extraordinary level of concentration and fast decision making capacity".

Advantages of improved grading accuracy

When fruit are close to the grade standard tolerances (percentage of defect fruit in the export box), a packhouse with blemish sorting equipment only has to focus on tables with marginal fruit. This is a completely different paradigm to that of delivering equal portions of fruit across each grading table, and relying on graders / pairs of graders having the same ability to grade. Every quality control manager knows that graders have varying skill levels and that even their performance varies over time. Because of increased control over the grading table performance the packhouse manager has a tighter control over the rejects in the packed product. This translates into a number of benefits:

1. More reject fruit can be put in the export box whilst staying within the grade standard tolerances. Alternatively, should this be required by Zespri, fruit of higher standards (fewer defects) can be supplied. Either situation the grower benefits either by increased tray numbers or by an expected premium for the fruit.

2. There is less panic and less risk of over-grading when a difficult fruit line arrives on the sorting tables. Maria Blyde of Hume Pack-N-Cool says: "There are no fears of being able to manage high reject Gold crops; stress decreased and production increased".

Infrared Technology benefits

The additional trialing at Apata of the Infrared technology yielded much. Physical damage on Gold fruit at the time of

Left: Hume Pack-N-Cool pre-grading line at full tilt.

picking will continue to be a thorn in a packers' side and whilst there will be a continued focus on quality at picking, there is an inevitable level of damage. Infrared assisted in identifying this recent physical damage, and delivering that to one grading table for closer inspection. It is very difficult for grading staff to adjust focus between large dark blemishes on a fruit to then drill down for miniscule beak damage. By segregating any fruit that looked remotely damaged away from the graders who focus on marginal blemish lines, Apata developed specialists that were very good at different categories of defect. Whilst it was not 100% accurate, the result was that staying in grade was never in question during export quality checks.

Certainty of quality and supply

As packhouses with blemish grading equipment have a more consistent export quality product, the ability to supply "just in time" export orders can be enhanced. This particularly applied to Gold fruit this year where physical damage could be detected with the help of Infrared technology. Also, having confidence in the grading standards allows any packhouse with the equipment to assist with short orders on vessels from other facilities. This is an advantage while presorting is not required yet, but when the technology becomes standard in the industry the advantage of surety of quality for shipping becomes an advantage to Zespri's planning and shipment ordering functions. This is ultimately a benefit to the national Gold pool.

Certainty of capacity

No Gold packing operator can confidently know how many trays per bin he or she can process in a day, because of the huge impact the reject rate and reject volatility has on a packing shed. This means that Gold packers make a best guess of their seasonal capacity, and contract growers accordingly. It is within the interests of packers to commit and utilise 100% of their capacity, but this then has the down side of perhaps over-committing. Presorting technology provides a packhouse management a much more solid understanding of the capacity of their site.

Leveraged existing resources

A general comment from the packhouse staff interviewed was that they are able to produce more or the same number of trays of export fruit while dealing with higher level of rejects and less staff. On the grading table, each fruit requires a decision made on it, and in Apata's case the average for 2004 was 83 fruit per minute per person. For 2005, they averaged 117 fruit per minute per person, and still had spare capacity. Therefore, the grading table no longer becomes a bottleneck and the capacity on poor quality lines is even increased between 50-100%. Stuart Weston says "As a general rule, Gold packers will operate on Gold fruit at about half the speed they would on Green. If a labour unit contributes 40 trays per hour in a Green shed, that labour unit may only contribute 27 trays per hour in a Gold shed. In broad terms comparing Gold to Green, our plant operates at half utilization for plant, and two thirds utilization for people. This loss of efficiency has been explained away by "handling characteristics of the fruit"

which require to be packed slower. This is true to a point, but a good proportion of this lost efficiency is more appropriately attributed to the volatility of reject rates. Within a grower line and between grower lines, packhouses will see wild swings in reject rate which either requires moving staff around the shed, or slowing the machine down to get through a bad patch. Our own experience has been as extreme as moving from a 10% reject rate line to a 50% reject line, requiring the whole shed to be reconfigured, and then back to a 7% reject line the next day! This state of flux creates a huge amount of labour and plant redundancy in a day".

By a pre-sorter shaving off the reject rate "peaks", the configuration of the shed and staff becomes more settled, as consistent production is delivered to the shed all day every day. Existing resources are therefore better utilized.

The future of blemish grading

Improvements in reliability

As blemish/Infrared grading is a global phenomenon in the food industry and equipment suppliers are competing in this global market, Compac (and its competitors) have a very strong commitment to make the equipment perform to the highest degree of reliability (intra and inter lane repeatability).

Continued improvements in the equipment and increasing staff confidence with it, mean that there are excellent prospects for a good financial return on this investment for both the postharvest facility and their clients.

Improved staff utilisation

Tray output per staff member is expected to further increase. Staff efficiency will not only go up because of higher grading accuracy, but also because of delivering a constant number of fruit to the packing arms, therefore less fluctuations in the tray output. This benefit was already signalled by Mark Hume, CEO of Hume Pack-N-Cool in his first year of using the equipment: "No matter what the reject rate, the throughput stays the same, packing costs are kept down and that's got to be good news for growers".

Increase in existing plant capacity

The packing capacity of existing plant and equipment will increase in the industry when more facilities adopt the optical and infrared technology as the same fruit is packed over a shorter period of time.

Coolstores for bin storage of Green fruit currently store all the fruit harvested from an orchard. This includes undersized and real reject fruit. During midnight hours the fruit can be pre-graded before entering the coolstores, which can save 10% coolstore space.

Improved competitiveness

The technology will help those who apply it to compete on price as well as pack out results. This will only get better in the future. However there is probably a more important aspect here and that is the ever increasing performance demands in the market place. Although Zespri's fruit is well known for

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its unsurpassed quality, the market generally or some clients in particular, could demand even higher internal and outward quality. With the technology discussed in this article Zespri has the ability to respond to those demands.

Benefits for growers

What does the grower get out of all this? In the first place, more export trays. By having more confidence in the consistency of performance, quality control staff are then at liberty to work closer to the marketers' grading standard tolerances at all times. By contrast in the "have-not" sheds, grading and quality control staff can struggle to stay in grade during difficult patches, inevitably rejecting much more fruit than is necessary to stay within a comfort zone. Improved capacity and confidence to work closer to tolerances results in a far better packout for a grower. The gains here are much more than suggested by the "reject fruit in export trays" statistics.

Also there should be less need for repacking Gold fruit shortly after packing, as many growers have experienced during the 2005 season. Although the equipment needs to be developed further, there is a strong expectation that fruit with scuffs and with beak damage will be removed in the future. Consequently there will be lower fruit losses on shore (with less repacking costs), and improved fruit quality overseas (reduced outturn penalties).

Conclusion

The optical and infrared technology is very promising and can be seen as the next step up in improving packhouse handling of

the fruit and increasing grower returns. Cost savings are much beyond the savings in grading staff considering the improved efficiencies of the whole packhouse and the increased pack out results of each grower line. Management of Apata, Seeka and Hume Pack-N-Cool are excited about its potential and have seen sufficient evidence in the last season(s) to believe that it is certainly going to work for them and their growers.

Stuart Weston comments: "We are very happy we have made this investment! I expect that this technology will eventually become standard equipment for serious Gold packers".

Mark Hume, who was the only one among the three packhouse packing all his Green fruit with the blemish grader is equally convinced that having this equipment for the Green crop is an absolute must.

Acknowledgment

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John Bosch is an independent provider of business development - and grower services. He was formerly managing director of Te Puke postharvest supplier Eleos, which was an innovator in the use of near infrared technology.

Compac blemish technology equipment installed at Seeka, Te Puke.

Photos courtesy of Compac Sorting Equipment Ltd.

