Potato Optical Grading – Horizon Scanning Technology and Equipment

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Disclaimer

This report has been prepared for Highland and Islands Enterprise by SAC Consulting Ltd.

This report aims to aid growers understanding of potato optical grading technology, providing the tools to recognise which equipment works best for specific tasks and some considerations when choosing a solution.

No responsibility is accepted for any misinterpretation which may be made within the contents of the report.

Figure 1 – camera unit inside a Flikweert Vision Quality Grader

Contents

Executive Summary

Sorting and grading potatoes may seem simple, but anyone who's done it knows how tricky it can be. While human pickers are skilled at spotting defects, it's a slow, labour-intensive job and mistakes are easy to make when thousands of tubers move across the line each day.

Optical sorting (sometimes called digital sorting) is the automated process of sorting solid products using cameras and or lasers

There are now several machines on the market capable of optically sorting unwashed potatoes, either by sizing tubers, removing skin blemish defects, damaged or rotten tubers, foreign objects, or everything in between all at once. Although optical graders working on washed tubers in industrial packing and processing factories have been deploying for a relatively long time it is only recently that systems operating on unwashed crops have been available at a farm scale level. Most options available on the market today are largely aimed at seed growers but they are also capable of handling ware crops.

Introduction

Sourcing and training reliable, good picking staff is not easy. Efficiency is key to optimizing potato production and increasing profit margins. Therefore, consistent product output with the potential to reduce labour costs are key to productivity gains, notwithstanding the added benefit of faster, more accurate selection or sorting.

For farmers, investing in robotics and automation remains at high risk unless there is clear evidence that a solution will work in their specific operating environment, integrate with existing practices, and deliver tangible value over time.

This report explores what optical sorting is, how it works, lists current providers, and compares options currently available on the market. The report aims to aid growers understanding of optical technology, providing the tools to recognise which equipment works best for specific tasks and some considerations when choosing a solution.

Although focusing on potato, it's worth noting that some optical machines can handle other vegetable crops as well, such as onions.

To get the most out of optical grading technology, following good agronomy practice across the season pays dividends, both in field and in store. For example, tubers should have completed the skin setting process prior to harvest. Ideally, pickers should be stationed on harvesters, so boxes contain minimum debris haulm, soil, stone, and clod. During storage, boxes should be well ventilated and dried thoroughly prior to grading.

What Are Optical Graders?

Optical graders are machines that use advanced imaging systems, sensors, and machine learning technology (Artificial Intelligence) to assess and sort potatoes based on specific parameters, such as their quality, size, shape, volume and potential defects.

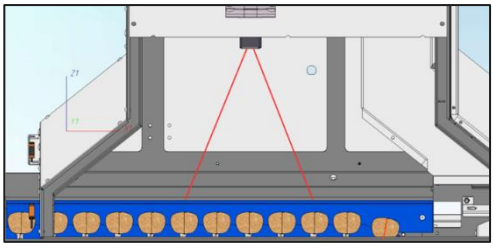


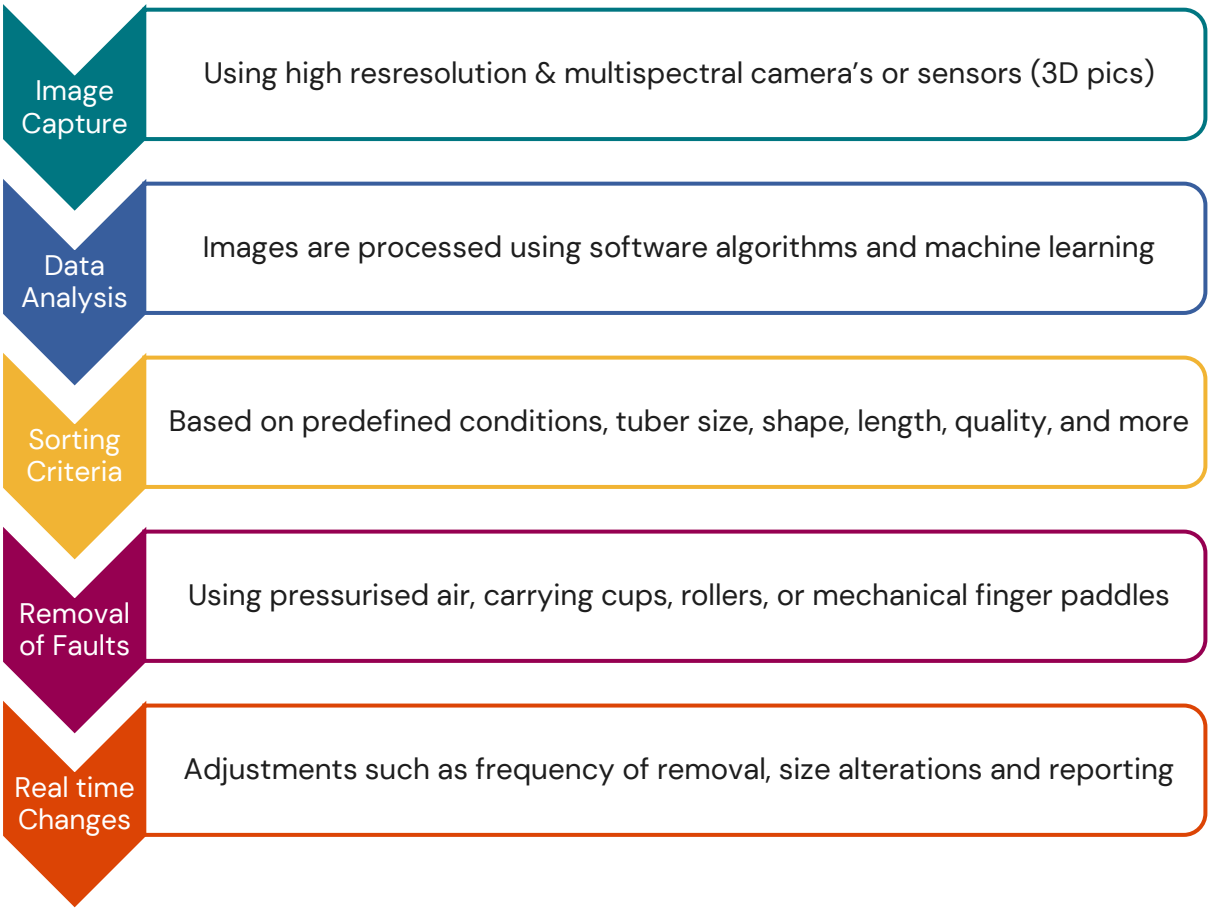
Figure 2 - camera angle looking down at potatoes over a roller table

Some machines can select for stone, clod and foreign object removal. While others grade by size or quality. Certain optical grading models include selection for all the above. Such models can provide accurate and bespoke size grading for immediate profitability gains. For example, adjustments to the tuber length parameters, could allow for selection of shorter potatoes from a long oval variety which are preferred for use on a cup planter. Most machines provide grade out information after a select number of tubers have passed through the system, which can assist stock management decisions and whether to increase or decrease fault removal frequency.

Optical graders can also work for as long as required, reducing the barrier of natural human fatigue during repetitive tasks over long periods of time. The machines can also work past normal working hours, when required, which is essential during peak delivery periods. Regardless of manufacturer and model, there are a range of options available to suit individual budgets and business needs.

How Do They Work?

Optical graders use cameras and sensors to take multiple images or scans of potato tubers, allowing image processing software and algorithms to make decisions based on the users pre-defined criteria. A simple example of this would be, is the object a potato or not. Every machine is different, and each will perform tasks in a different way depending on the type of hardware and software installed. However, most machines will follow a similar process listed below:



The number of cameras, quality, and quantity of images taken of each individual tuber influences the speed and accuracy of machines. Differences in camera specifications across optical graders produce different outputs:

- ✓ **High resolution cameras** – capture images with many pixels, resulting in highly detailed and sharp photographs.
- ✓ **Multi-spectral cameras** - images are defined as collections of image layers of the same scene, each acquired at specific wavelength bands, commonly including bands in the visible spectrum and near infrared.

- ✓ **Near infrared cameras** – imaging systems designed to operate at wavelengths just beyond the visible spectrum. They are particularly useful for applications requiring high sensitivity and low-light performance.

- ✓ **Pulsed LED illumination** – cameras emit short bursts of LED (light emitting diode) light captured by cameras to reduce motion blur, ideal in a bulk sorting environment.

The AI models or machine learning systems inbuilt within most optical machines claim to correctly identify potato defects with up to 95% accuracy. Though most are unlikely to regularly achieve this.

These models can identify multiple defects on a single potato while maintaining real-time processing speed. However, accuracy is constrained by some limiting factors.

For example, **if you can't see something with the naked eye, then neither can the cameras.**

Optical machines operate on confidence levels based on the images they are provided**.** The cleaner a sample is going through the machine, the more confident it will be at correctly identifying the object or issue. In turn, the more accurate the frequency of removal will be. **Therefore, stock presentation is key.**

Figure 3 - potatoes moving over a roller table

Earthy stocks or tubers displaying surface moisture can disrupt and confuse cameras, which may lead to machines making wrong decisions. However, most software available has been trained to recognise all major defects including rots, scabs, black scurf, greens, damage and cracks, depending on make and model of machine. This technology has been deliberately trained to recognise faults on different varieties in the presence of some (limited) soil adhesion. The process is precise and achieved by software developers and engineers capturing thousands of images of defects, on numerous varieties, each uniquely shaped, assorted by size and skin colour. Naturally, defects range in severity, so the model behind the cameras must recognise how badly effected a tuber is and whether to reject it or not.

Most optical graders work on confidence thresholds or penalty points for defect detection but for a limited number of machines, they can work on specific surface area detection which can be set by the user. For illustration, you might decide for

a particular market you wish to remove all tubers with over 20% surface area infection with common scab.

All optical graders require an internet or local area network (LAN) connection, using an ethernet cable. They can operate offline but require a strong internet connection during software updates or during periods of remote support. As optical graders are mostly connected to the internet, the producing companies can collect information to continually improve and update software systems and fault identification. For example, if a machine hasn't encountered a specific problematic type of scab lesion before, it will struggle to identify and sort it correctly. Remote engineers can guide owners through the process of capturing images of affected tubers, to remotely train the software to overcome the challenge in the space of a few hours or less in some cases.

It's worth noting that most companies charge a subscription for remote service and software support, this can range from £2,000 to £4,000 per year

Most machines operate a standard user interface, which can be located near the machine itself, in the form of a monitor or display. Some user interfaces can be adapted to work on tablets or iPads, providing workers with control semi-remotely. Users have the power to adjust or set parameters through the interface to set the removal frequency of tubers with skin defects (or waste), choose an exit lane for specific faults if appropriate, or adjust the tuber size parameters based on order or choice. Generally, this function is performed by a selection of buttons, typing text information or moving sliding bars (0-100% removal).

Selection criteria differ between models, but most are intuitive. Remote support and installation engineers can help guide store managers through the use process at installation. On most machines, specific selection criteria can be saved so users don't have to continually adjust parameters.

It's worth noting that the tighter the parameters set, the more likely clean potatoes will also be rejected accidentally

Figure 4 – Schouten Optica Q user interface with grower interpretation

To ensure compatibility with your current grading equipment, it's recommended to consult with the manufacturer or supplier prior to purchase. They can provide expert guidance on which solutions will work best with your current technology and machinery. Most options on the market can be

retrospectively fitted and wired into existing grading lines and equipment. Where this becomes more challenging is with units which can optically size as well as select for quality. These are generally much larger and longer machines, purely because of the way the tubers are singularly presented to the cameras and the number of outlets they contain. Some might need adjustments or alterations to fit bag or box fillers, for instance.

Options By Requirement

There are different options available depending on needs and priorities of individuals. These options have been split into four categories for simplicity, although some machines may be capable of performing additional tasks than others. Spare parts should be provided as standard when purchasing any equipment.

1. Pre-Cleaning Options

If stones, clods, haulm and foreign objects are of primary concern, then an optical pre-cleaning choice is a good fit.

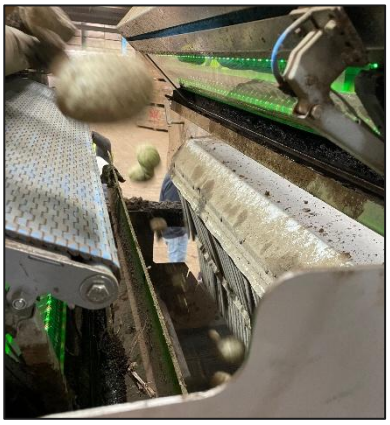


Figure 5 - Raytec Vision Raynbow cameras and ejectors

Machines such as the *Tomra 3A*, *Downs Crop Vision Plus*, *Flikweert Vision Divider* or *Raytec Vision Ingenuity* provide able solutions.

Each designed for maximum throughput and straightforward installation. These machines can supplement or remove the need for existing pre-cleaning equipment. Suitable for into store handling, pre-grading, or packing operations. The benefits to using a pre-cleaning optical system allows picking staff to focus on quality selection of tubers, such as the removal of scab, rather than stone, clod, haulm or damage. Most of these machines capture images of tubers in flight (other than the *Divider*), ejecting defects using plastic paddles to knock out faults.
Average price ranges between £100k to £180k.

Stone/clod	Damage	Greens	Misshapes	Pest holes	Rhizoctonia	Scab	Rots	Tuber sizing
✓	✓	✓	✓				✓	

KEY: green = selection criteria for all / orange = additional criteria for some models

2. Quality Only Options

If the objective is to deploy an optical solution to grade for quality only, removing an element of stone and clod but primarily focusing on tuber skin finish and consistency, then a quality only solution is a good option.

Machines such as the *Flikweert Quality Grader, Schouten Optica Q, Wevano JCL-1000, Herbert Oculus* or *TechNature Potato Cam* are all viable choices.

The machinery options listed above must recognise a higher volume of potential defects, so speed is somewhat reduced when compared to a pre-cleaning option. Well-presented tubers are key to optimising productivity and accuracy. Most models claim they can achieve up to 20 tonnes per hour. However, tuber size and regularity of tuber size/shape also influence throughput. For example, sorting chats sized 28x35mm, will likely handle 3-6 tonnes per hour, as opposed to 35x55mm seed, which is more likely to achieve 10-15 tonnes per hour.

Quality only machines are relatively compact and mostly straightforward to install within existing grading lines. Most machines are fitted in front of existing picking tables, providing growers flexibility to manually sort too. These machines work by ejecting defects using plastic paddles to change the trajectory and direction of faults. They typically have three outlets, allowing operators to select direction of material to outlet choice. Stone and clod down one and brock down the other, with clean product going straight through, for instance. It could be argued that this method of fault removal may be less gentle when compared to others, some have significant drop heights, although cushioned by angled fall breakers.

Figure 6 - Flikweert Vision Quality Grader finger paddles, removing faults

Growers should consider even flow hoppers prior to some quality only optical graders to optimise throughput and accuracy, in addition to pre-cleaning kit. Examples of pre-cleaning equipment could be a set of coils, a pintle belt, brusher, optical pre-cleaner, or several options in combination. Dust extraction must be considered. Stocks should be well dried, allowing any adhering soil to be removed as best as possible. Average price ranges between £180k to £280k.

Stone/clod	Damage	Greens	Misshapes	Pest holes	Rhizoctonia	Scab	Rots	Tuber sizing
✓	✓	✓	✓			✓	✓	✓

KEY: green = selection criteria for all / orange = additional criteria for some models

3. Size Only Option

Maximising sizing efficiency can be achieved through a limited number of optical sizing only options.

The Schouten *Optica CS* can accurately sort tubers based on square size, in addition to separating clods and stones. Whereas the *Smart Grader Reader+* can be set to maximise a single size fraction at the end of grading lines.

Figure 7- Optica CS

Unlike screen graders, a size only machine can change the sizing parameters at the click of a button, instead of physically changing cumbersome riddles. The improvement in more accurate sizing can maximise tubers within saleable size fractions, boosting yield and profitability. Both machines use a pulse of pressurised air to push tubers down desired outlets. The *Optica CS* is easily cleaned out and offers around 12-18 tonnes per hour work rate, depending on stock presentation, tuber size and the number of outlets.

However, the *Optica CS* is large and requires grading infrastructure around it. This might result in less existing equipment being appropriate and utilised. Incurring substantial investment but without the choice to optically grade for quality defects at the same time. The *Reader +* can be used as a post-check on the top size riddle so that a higher yield can be achieved, especially in long shaped varieties. Average price ranges between £38k to £460k.

Stone/clod	Damage	Greens	Misshapes	Pest holes	Rhizoctonia	Scab	Rots	Tuber sizing
✓								✓

KEY: green = selection criteria for all / orange = additional criteria for some models

4. Size and Quality Options

If an optical machine to sort everything at the same time (sizing, grading and some cleaning) is required then a size and quality option is the best solution.

Machines such as *Innova U-vision, Smart Grader Evo, Newtec Cellox* or *Ellips Elisam* are all potential options.

These machines require tubers to be lined up individually in lanes for cameras to capture multiple images and make complex decisions. They are the most sophisticated machines available meaning the processing power is also the highest out of all the available categories. Therefore, work rate is reduced, and computer servers must be housed (over pressure) and shed space considered when selecting these options.

Figure 8 - Innova U-Vision optical unit tuber selection using cups and drops

Depending on the model, tuber size, and soil adhesion, these machines can achieve up to 12+ tonnes per hour, subject to number of lanes. Perhaps unsurprisingly, they are also the most expensive and largest options on the market. However, they are highly accurate and in situations where identification is difficult or problematic, most have a return function to allow tubers to be reprocessed through the optical section for a second try at recognition.

Size and quality machines offer all the advantages previously discussed in earlier sections of this document but offer greatest flexibility to users. Tuber sizing for example, can be accurate up to 0.1 mm, this presents immediate profitability gains when working with awkwardly shaped varieties. Due to their modular design, additional offtake lanes can be added to most machines, permitting several sizes to be graded at once. They can also grade by tuber shape or volume, if users wish. These machines work by selecting potatoes using pressurised air, finger, cup, or roller drop systems. Most boast gentle handling of crop and some can be adapted to accommodate washed product.

It is highly recommended that growers include pre-cleaning kit on grading lines prior to size and quality machines.

Examples of pre-cleaning equipment could be haulm rollers, a set of coils, a pintle belt, brusher, optical pre-cleaner, or several options in combination. Growers should also consider even flow hoppers to optimise throughput and accuracy. Stocks should be well dried, allowing any adhering soil to be manageably removed. No large objects should reach these machines. Appropriate dust extraction is essential. Average price ranges between £350k to £500k+.

Stone/clod	Damage	Greens	Misshapes	Pest holes	Rhizoctonia	Scab	Rots	Tuber sizing
✓	✓	✓	✓	✓	✓	✓	✓	✓

KEY: green = selection criteria for all / orange = additional criteria for some models

List Of Suppliers

Additional and existing manufacturers are continually developing new optical solutions. Therefore, this list is up to date as of April 2026. We recommend you speak to an appropriate advisory service or manufacturer for the latest list of providers.

It's worth noting that companies often have an agent or distributor representing them in a particular territory. If known, this has been taken into consideration below. Often, the price quoted by the manufacturer is less than the regional distributor so mechanically minded growers might be able to take advantage of direct purchase.

DOWNS INNOVATION & PERFORMANCE

ellips

Flikweert Vision

INOVAA

KEY TECHNOLOGY A DURAVANT COMPANY

NEWTEC

raytec VISION AN ATS COMPANY

SCHOUTEN AGRI SORTING SOLUTIONS

Smart Grader By GeJo Grading Services B.V.

TechNature

TOMRA

wevano machinery

Potato Optical Grading

COMPANY	CONTACT DETAILS	LOCAL AGENT	CONTACT DETAILS
DOWNS (French)	**Tel:** + 33 (0) 328 405 858 **Email:** contact@groupedubrulle.com **Website:** https://www.downs-fr.com/produits/downs-cropvision/		
Ellips (Dutch)	**Tel:** +31 (0) 402 456 540 **Email:** info@ellips.com **Website:** https://ellips.com/grading-solutions/elisam-grading-machine/		
Flikweert Vision (Dutch)	**Tel:** +31 (0) 111 219 000 **Email:** info@flikweertvision.nl **Website:** Home - Flikweert Vision	**CC Powell Ltd** (Chris Powell) (Banff)	**Tel:** 01261 839190 **Email:** admin@ccpowell.co.uk **Website:** https://ccpowell.co.uk/
Innova (Dutch)	**Tel:** +31 (0) 527 794 525 **Email:** info@inovaa.nl **Website:** https://inovaa.eu/u-vision/	**AgroPack Solutions Ltd** (Willie Kyle) (Elgin)	**Tel:** 07415 144 263 **Email:** info@agropacksolutions.com **Website:** https://agropacksolutions.com/

Key Technologies (Dutch)	**Tel:** +31 (0) 345 509 900 **Email:** - **Website:** https://www.key.net/en/products/oculus-whole-potato-optical-sorter/	**Flo-Mech** (Adrian Head) (Peterborough)	**Tel:** 01733 233 166 **Email:** enquiries@flo-mech.com **Website:** https://www.flo-mech.com/
Newtec (Danish)	**Tel:** +45 (0) 661 584 44 **Email:** sales@newtec.com **Website:** https://www.newtec.com/machines/optical-sorting-machines/potatoes		
Raytec Vision (Italian)	**Tel:** +39 (0) 521 303 427 **Email:** raytec.info@raytecvision.com **Website:** https://www.raytecvision.com/en/	**Projx Innovative Engineering & Services** (Adrian Moye) (Lincolnshire)	**Tel:** 0118 9797 667 **Email:** sales@projx-services.com **Website:** https://www.projx-services.com/optical-sorting/
Schouten / Tolsma Grisnich (Dutch)	**Tel:** +31 (0) 229 502 150 **Email:** info@schoutensorting.com **Website:** https://schoutensorting.com/en/	**Alan MacKay Machinery** (Forfar)	**Tel:** 01307 462081 **Email:** admin@alanmackay.co.uk **Website:** https://www.alanmackay.co.uk/
Smart Grader (Dutch)	**Tel:** +31 (0) 622 301 963 **Email:** info@smartgrader.com		

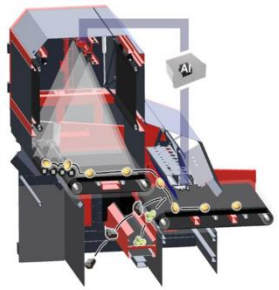
	Website: https://smartgrader.com/en/solutions/sort-size-and-quality/		
TechNature / Skalls (Dutch)	**Tel:** +31 (0) 613 198 301 **Email:** wouter.bac@technature.nl **Website:** https://www.technature.nl/en/producten/optische-sorteermachines/potatocam	**Alan Twatt** (Banff)	**Tel:** 0797 090 9130 **Email: -** **Website:** https://www.atpots.co.uk/
Tomra (Belgian)	**Tel:** +32 (0) 163 963 96 **Email: -** **Website:** https://www.tomra.com/food/machines/tomra-3a	**Alan MacKay Machinery** (Forfar)	**Tel:** 01307 462081 **Email:** admin@alanmackay.co.uk **Website:** https://www.alanmackay.co.uk/
Wavano (Dutch)	**Tel:** +31 (0) 514 569 277 **Email:** info@wevano.nl **Website:** https://wevano.nl/en/agrarisch/sorting/	**AgroPack Solutions Ltd** (Willie Kyle) (Elgin)	**Tel:** 07415 144 263 **Email:** info@agropacksolutions.com **Website:** https://agropacksolutions.com/

List Of Products/Equipment

The optical graders listed below are available on the market as of April 2026. Full specifications and customisable configurations can be found by contacting the manufacturer. Each model has been broken down by requirement or category of sorting for ease of comparison.

1. Pre-Cleaning Options

DOWNS – CropVision (Plus version available)



Dimensions: H – 320cm / L – 510cm / B – 110-280cm
Work rate: up to 100 tonnes per hour
Cameras: 2-5 cameras (model dependant) high resolution industrial cameras, 360° image capture of tubers in flight
Removal: via plastic finger paddles
✓ stone, clod, greens, cuts, cracks, misshapes
Power: *supply* – 3 Phase + T + N
voltage – 400v
pressure – 7.5kw compressor + air dryer
Others: three outlets available for separation of waste/defect potatoes and good crop, built in self-cleaning system, self-standing, height adjustable and mobile

FLIKWEERT VISION – Divider (Pro version available)

Dimensions: H - 150cm / L – 375cm / B – 150-350cm
Work rate: relative to belt width, 40-120 tonnes per hour
Cameras: several high-resolution industrial cameras, capture objects while stationary on conveyor belt
Removal: via plastic finger paddles
✓ stone, clod, foreign objects
Power: *supply* – 16A 3 Phase + PE
voltage – 400V AC ±5%
pressure – 4.5 bar
Others: two outlets, one for trash and the other for crop, machine available in several widths, lowest drop height in this category (35cm)

TOMRA – 3A

Dimensions: H – 198cm / L – 352cm / B – 211-331cm
Work rate: up to 100 tonnes per hour
Cameras: several high-resolution industrial cameras multi-spectral pulsed LED illumination, and NIR colour sensors, image capture of tubers in flight
Removal: via plastic finger paddles
✓ stone, clod, greens, foreign objects
Power: *supply* – 3 Phase + Neutral
voltage – 4k VA
pressure – 7 bar
Others: two outlets, one for trash and the other for crop, accommodates various soil types and coverage, working on a limited portion of potato for identification, suitable for outdoor use

RAYTEC VISION – Raynbow

Dimensions: H – 196cm / L – 440cm / B – 75cm-175cm
Work rate: up to 120 tonnes per hour
Cameras: several visible colour technologies and NIR sensors, image capture of tubers in flight
Removal: via plastic finger paddles
✓ stone, clod, greens, cuts, cracks, misshapes
Power: *supply* – 3 Phase + Ground
voltage – 400-480 V
pressure – 8 bar
Others: three outlets available for separation of waste/defect potatoes and good crop, lower specification compared to *Raytec Ingenuity* model

Figure 9 - Downs CropVision mechanical ejection fingers

RAYTEC VISION – Ingenuity

Dimensions: H – 141cm / L – 385cm / B – 150-250cm
Work rate: up to 120+ tonnes per hour
Cameras: several visible colour technologies and NIR sensors, with double vision, image capture of tubers in flight
Removal: via plastic finger paddles
✓ stone, clod, greens, cuts, cracks, misshapes
Power: *supply* – 3 Phase + G
voltage – 400-480 V
pressure – 6-8 bar
Others: available in two- or three-way sorting capacity, pintle belt landing conveyor as standard

2. Quality Only Options

FLIKWEERT VISION – Quality Grader

Dimensions: H – 234cm / L –340cm / B – 157cm
Work rate: up to 20 tonnes per hour
Cameras: six high resolution cameras, capturing at least 10 images per tuber at different angles
Removal: via plastic finger paddles
✓ stone, clod, greens, scab, damage, misshapes, growth cracks, rots, wireworm
Power: *supply* – 16A 3 Phase + PE
voltage – 400v AC
pressure – ± 4.5 bar
Others: older models with two outlets require additional equipment to separate foreign material and potatoes (called a *Reject Separator*), new models now have three outlets available for separation of waste/defect potatoes and good crop

Figure 10 - remote support engineer

SCHOUTEN – Optica Q

Dimensions: H – 215cm / L – 490cm / B – 115cm
Work rate: 15-18 tonnes per hour
Cameras: four high resolution colour cameras, with flashlight as standard
Removal: via plastic finger paddles
✓ stone, clod, greens, scab, rhizoctonia, damage, misshapes, growth cracks, rots, wireworm
Power: *supply* – 3 Phase + Zero + Ground
voltage – 400v
pressure – 5 bar
Others: three outlets available for separation of waste/defect potatoes and good crop, less noisy than other models during sorting, daily reports available

WEVANO - JCL-1000

Dimensions: H – 209cm / L – 328cm / B – 100cm
Work rate: up to 10-12 tonnes per hour
Cameras: three high-resolution cameras take at least thirty images per object
Removal: via plastic finger paddles
✓ stone, clod, greens, scab, damage, misshapes, growth cracks, rots, wireworm, + limited tuber sizing
Power: *supply* – 3 Phase
voltage – 400v
pressure – 5-6 bar
Others: three outlets available for separation of waste/defect potatoes and good crop, machine capable of sizing under or oversize tubers + quality sorting – one of 2 machines capable of partial sizing in its class. Featuring U-Vision software

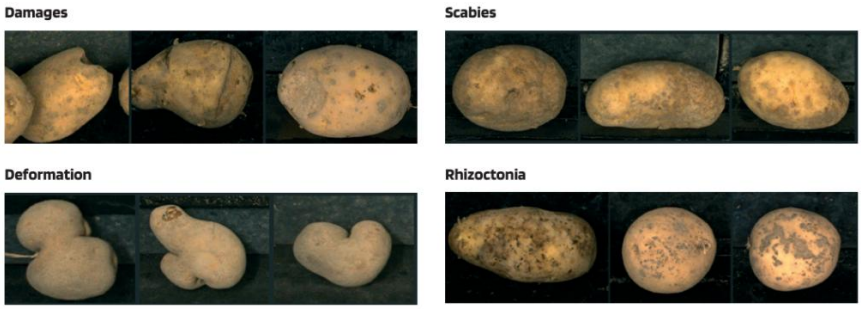


Figure 11 – JCL-1000 defect image capture available on user interface

HERBERT – Oculus

Dimensions: H – 278-265cm / L – 309cm / B – 189-219cm
Work rate: up to 25 tonnes per hour (width dependant)
Cameras: three/four high resolution colour cameras + NIR with LED lighting, taking at least 16 images per object
Removal: via plastic finger paddles
- ✓ stone, clod, greens, scab, damage, misshapes, growth cracks, rots, wireworm, partial tuber sizing

Power: *supply* – 16A 3 Phase + Neutral
voltage – 400v
pressure – 6 bar
Others: three outlets available for separation of waste/defect potatoes and good crop, machine capable of sizing under or oversize tubers + quality sorting – one of 2 machines capable of partial sizing in its class. Primarily developed for washed potatoes but limited use on unwashed crop in Europe

TECHNATURE - Potato Cam

Dimensions: H – 263cm / L – 379cm / B – 100+cm
Work rate: up to 16 tonnes per hour
Cameras: 12 high resolution colour cameras, taking at least 16 images per object
Removal: via plastic finger paddles
- ✓ stone, clod, greens, scab, damage, misshapes, growth cracks, rots, wireworm

Power: supply – 3 Phase
voltage – 400v
pressure – 5-6 bar
Others: three outlets available for separation of waste/defect potatoes and good crop, equipped with unique shaped rollers to help singular tubers through the optical unit, only machine in class to include top and side cameras

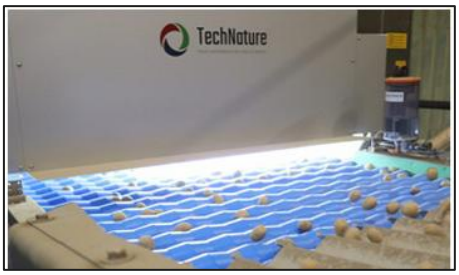
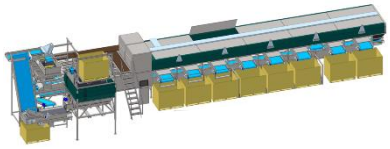


Figure 12 - PotatoCam unique shaped rollers help separate tubers

3. Size Only Options

SCHOUTEN – Optica CS



Dimensions: H – 550cm (including tippler) / L – 2400cm / B – 265 (machine only) - 500cm (plus outlets)
Work rate: up to 12-18 tonnes per hour
Cameras: several producing 3D scans of tubers
Removal: compressed air and conveyors
✓ stone, clod, tuber sizing to 0.1 mm accuracy
Power: *supply* – 3 Phase + Neutral + Ground
voltage – 400v
pressure – 9 bar
Others: a shaking bin ensures product is fed consistently to line up tubers. Stock must be free of <25mm and large objects >100mm, prior to reaching the optical section. Machine can run unsupervised after setup until the feed stops or discharge is full

SMART GRADER – Reader +

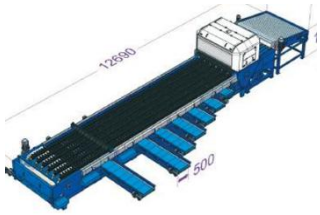
Dimensions: H – 721cm / L – 227cm / B – 415cm
Work rate: 6 tonnes per hour (average tuber weight of 150g)
Cameras: single camera
Removal: compressed air and conveyors
✓ tuber sizing only
Power: *supply* – 3 Phase
voltage – 230v
pressure – 8 bar
Others: users can record data but also sort directly based on measurement results, optimising the top riddle marketable size fraction, especially in longer shaped varieties

Figure 13 - Optica CS intake – string belts

4. Size and Quality Options

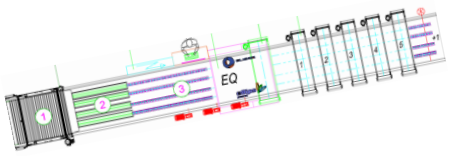
The number of lanes a machine has directly influences throughput.
Typically, configurations consist of 4, 8, or 12 lanes servicing optical sections.

INNOVA – U-Vision



Dimensions: H – 126cm / L – 1269cm / B – 206cm
Work rate: up to 10-12 tonnes per hour
Cameras: several high-resolution colour cameras, capture between 35-50 images per object
Removal: individual cups and drops onto conveyors
✓ all defects + tuber sizing to 0.5 mm accuracy
Power: *supply* – 3 Phase (server unit requires separate power)
voltage – 400v
pressure – N/A (no secondary energy supply needed)
Others: sizing can be done by square size as well as length or volume, return system built in, for greater optical accuracy. User interface can be controlled semi-remotely

ELLIPS – Elisam

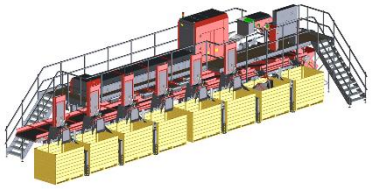


Dimensions: H – 140cm / L – 1300cm / B – 150cm
Work rate: up to 11 tonnes per hour (depending on roller size)
Cameras: one camera per lane but with the option of additional side cameras capturing high resolution multi spectral colour images + infra-red technology
Removal: rollers with solenoids to eject graded produce into exits
✓ all defects + tuber sizing to 0.1 mm
Power: *supply* – 3 Phase + Neutral + Ground (server unit requires separate power)
voltage – 400v
pressure – 8 bar
Others: machine primarily developed for washed potatoes, but software capable of running unwashed crop. Return system built in, for greater optical accuracy. Company known for their camera technology and software. Quality grading can be achieved by selecting surface area removal

NEWTEC – Cellox-P-Dual-UHD

Dimensions: H – 243cm / L – 516-1322cm / B – 130cm
Work rate: up to 7.5-16.0 tonnes per hour
Cameras: several high-resolution colour cameras, 1 pixel = 0.16mm², taking up to 45 images per object
Removal: finger drop system (spinaflex™) onto conveyors
✓ all defects + tuber sizing to 0.1 mm
Power: supply – 3 Phase (server unit requires separate power)
voltage – 400v
pressure – 6 bar
Others: patented vibrating roller intake system, machine works best on washed potatoes, sizing can be done by square size as well as length or volume, easy access for cleaning and service, upgraded dual camera system recently developed

SMART GRADER - Evo



Dimensions: H – 406cm / L – 1217cm / B – 160cm (machine only, not including additional width of return belt and outlets)
Work rate: 1.5 tonne per hour per lane, from 6-12 tonnes per hour
Cameras: high resolution multi spectral colour cameras + infra-red technology, taking 15-30 images per object
Removal: compressed air and conveyors
✓ all defects + tuber sizing to 0.1 mm
Power: *supply* – 3 Phase (server unit requires separate power)
voltage – 400v
pressure – 10 bar
Others: quality grading can be achieved by selecting surface area removal. Return system built in, for greater optical accuracy. Sizing can be done by square size as well as length or volume. Compressed air removal system reduces maintenance, reducing the number of mechanical parts

Considerations and Conclusions

Investment in optical sorting solutions requires large capital investment. It's wise to investigate funding opportunities. However, pay-back could be relative to labour savings, improved grading accuracy, higher marketable yields, fewer rejections and improved seed health. For instance, installing a quality only optical option might require two less people on the picking table. The cost saving equivalent might be:

- ❖ Two people cost £15.00 per hour
- ❖ Working 8 hours per day, five days a week
- ❖ = 40 hours per week, costing £1,200 per week

- ✓ Potential saving of £4,800 per month

Notwithstanding, a reduction in any additional associated costs with staffing, such as insurance, accommodation, transportation, and more. The potential savings can soon mount up when employing multiple pickers for 6+ months of the year during the busy grading season.

Alternatively, if sourcing labour is a challenge, then optical solutions may also be the extra hands you need, without additional staff.
It may also provide an opportunity to upskill and retain existing workforce.

When working with a naturally perishable product, optical sorters have their limitations. Although they are highly advanced, and always strive for 100% accuracy, it is likely they will seldom achieve this. Most run at approximately 80-95% accuracy, nonetheless, this is still impressive precision. Especially when considering manual selection involves human perception, which can be subjective and prone to errors. What one picker might consider a defect, another might not, leading to inconsistency of fault removal.

Optical machines can work for as long as required, reducing the barrier of natural human fatigue during repetitive tasks over long periods of time. The machines can also work past normal working hours, when required, which is essential during peak delivery periods. Most machines require a substantial input of electricity. Typically work rate speed is reduced using some optical systems when

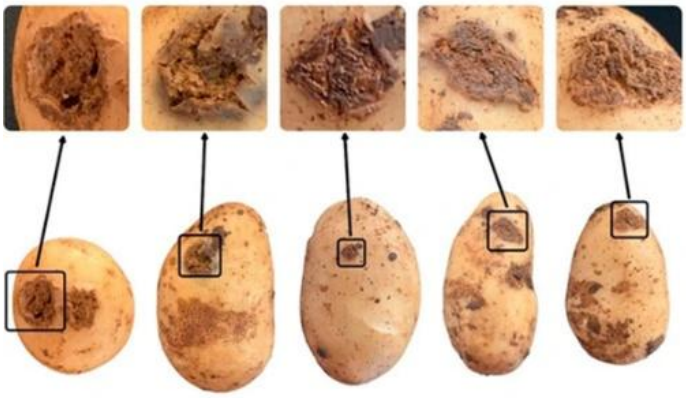


Figure 14 - common scab lesions identification on tubers

compared to conventional mechanical graders.
Especially on the most complex machines, requiring tubers to be lined up individually to picture and make judgements, creating a bottleneck to throughput. There's also a trade off or balancing act between speed and accuracy.

Some models aren't easily integrated or retrofitted into current grading systems. Therefore, they might require additional equipment such as belts and conveyors. Many optical graders have multiple configurations.

Dust extraction or dust reducing systems are recommended for most optical options and grading shed environments. However, it's wise to avoid over wetting tubers prior to optical grading. Fine misting systems over tipplers, pre-cleaning sections and bag fillers are a relatively low-cost option. More complex automatic self-cleaning filter systems with extensive pipework and extraction cost considerably more.

Optical grading machines have become popular, reliable, and readily available

Scale of business to support the viability of investment in optical grading solutions is subjective and based on individual circumstances. Whether growing seed or ware, high grade or basic seed, pre-pack or processing ware; the annual average yield, quality and price, via contracts or the open market, all factor into decision making. However, it may be justifiable for businesses producing between 2,000t of high-grade seed or 5,000t + of pre-pack ware annually to explore optical solutions.

Optical grading technology is continually improving. Hardware on machinery is unlikely to change much in the future, but the software will. Manufacturers expect the lifespan of machinery to be significant, but many wearing parts will need replaced within 2-4 years (plastics, chains, etc.), cameras perhaps 5-10 years and UPS (Uninterruptible Power Supply – device that protects computers from unexpected power interruptions) 5-7 years, providing annual servicing is maintained. Servicing costs will vary depending on type of machine and the time spent working on it, but for budgeting purposes £1,000 to £2,000 annually, would be sensible.

Payment of annual software subscriptions help continue and improve machine learning, which means the technology is advancing substantially every year. This helps improve accuracy, capacity, and decision-making speed. Many optical grading manufacturers have increased the number of staff working in engineering and software departments recently, demonstrating commitment.

Soon it's likely grading line upgrades will include optical sorting options as standard.

Decision flowchart

Deciding which optical grader is most appropriate, will largely be determined by identifying a solution to a challenge. For example, growing on marginal land which consistently contains above average stone content. An optical pre-cleaning option is an easy decision. However, many other factors influence product choice, including access to local support and return on investment.

Most growers will have already identified where an optical solution might provide added value to a business, however, the flowchart below helps support decision making.

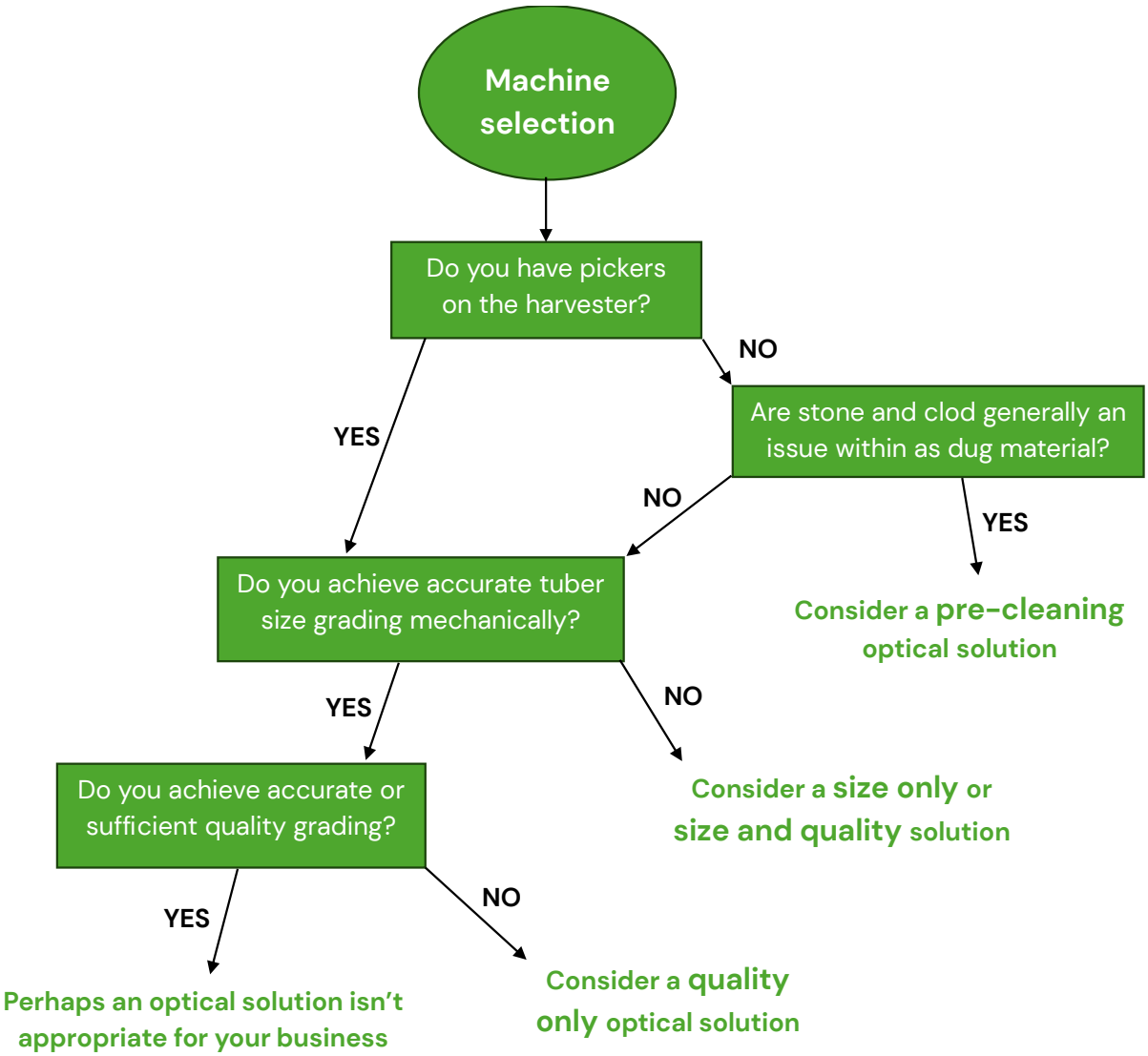


Figure 15 - decision making flowchart

Case Study

GROWER: W W Martin & Son Potatoes Ltd, Garguston Farm, Highland
SECTOR: High grade seed producer
OPTICAL UNIT: Flikweert Vision - Quality Grader

"Our new Tong potato grading line and Flikweert optical grader is a game changer for our business. We managed to access government grant and customer funding to help finance the cost. The optical sorting technology was essential, given labour shortfalls in our sector, the repetitive nature of hand-picking reject potatoes and the need to increase productivity to fulfil "just in time" orders.
In designing and planning our new line, we were insistent that any 3rd party optical unit would have to be incorporated and fully integrated into our new facility. Tong made this process simple and straightforward-even with retaining 25% of our existing equipment.

We designed the line so that pre-cleaning elements were incorporated prior to the optical system, such as coils, inspection belt, haulm roller and retractable dry brusher. This season, lifting conditions were favourable and crops came into store dry and relatively soil free. We haven't therefore had to brush many stocks. The optical unit has worked especially well across multiple varieties and soil types. On challenging stocks, with beyond tolerance levels of powdery scab, it has been fantastic at removing defects.

As yet we haven't addressed dust control. It hasn't been a big issue, and we thought it best to delay until we observed where the dust issues occur. The optical element requires a dry air supply which we have installed but it also needs to access ambient air. Currently, this is sourced from within the grading shed. On reflection, it would be preferable if this air was sourced from out with the shed or from the adjacent cold store.

Productivity was our main driver in committing to the new line. On average, we can achieve 16t/hour into jumbo bags with 4 operatives (2 on forklifts, 2 pickers) Therefore, 4 tonne per person, per hour. This productivity improvement equates to a doubling of previous output or a halving of labour cost. Either way, it has undoubtably made our grading system more efficient and cost-effective.
We also feel that we are now producing a more consistent product, which benefits our customers but also ourselves, as we retain a lot of early generation high grade seed for further multiplication. The data recording within the optical unit will also allow us to compare fields and make informed decision on future crops.

We are delighted with our optical grading unit. The technology is brilliant and we certainly wouldn't want to be without it."

Figure 16 – Quality Grader and potato grading line at W W Martin& Son Potatoes Ltd

If you would like any further information, please contact:

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