

PT439
Attendance at Potato Harvest 1994
demonstration, United Kingdom

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Tasmanian Department of Primary
Industry & Fisheries



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Harvest '94

STUDY TOUR REPORT

3-23 SEPTEMBER 1994

ATTENDED BY J MCPHEE

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**Department of
Primary Industry and Fisheries**
T A S M A N I A



HARVEST '94

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This study tour was jointly funded by the Horticultural Research and Development Corporation, the Tasmanian Department of Primary Industry and Fisheries and Dobson's Vegetable Machinery, Ulverstone, Tasmania.

Summary and recommendations

Harvest '94 was a good opportunity to view a large range of potato harvest, handling and transport technology in one place. The twin row harvesters, which are widely used in the UK and European potato industries, have some level of acceptance in Australia, but have not made any impression in the major processing production area of Tasmania. It is recommended that the processing industry seriously consider the pros and cons of the twin row system. As a first step in this process, an economic analysis of the harvest system is being undertaken within the Tasmanian DPIF.

It is also recommended that industry representatives from the farming, machinery, post-farm gate and research sectors should regularly visit the UK Potato Marketing Board demonstrations, which are held about every 18 months. These are showcases of the latest in overseas technology. While it is preferable to use Australian produced technology in the Australian potato industry wherever possible, it is important to keep abreast of developments overseas. There are many more similarities between most Australian production areas and the UK than there are with the major production areas of the USA.

Greater effort should be made to encourage the use of on-farm storage in the temperate production areas, such as Tasmania and Victoria, in order to avoid the problems of winter harvest. The temperate climate lends itself to the use of relatively low technology stores which rely primarily on ambient air ventilation.

Post-plant sub-soiling would appear to be worthy of further investigation as a means of improving infiltration and reducing erosion in potato crops. In many cropping systems, the benefits of compaction removal by deep tillage at the start of the season are lost due to excessive traffic by the end of the season.

Improvements in water application uniformity and yield appear to be possible with irrigation systems which differ from the travelling gun system currently used in some areas. There is scope for further work on this matter, and basic economic analyses of a variety of irrigation systems are currently underway in the Tasmanian DPIF.

On the issue of damage assessment, there should be a move by the various sectors of the processing industry to adopt a standard method by which damage can be assessed at intake. Some of the systems in use on the UK could be useful in this context.

The continued introduction and development of new technology is important to the future of the Australian potato industry. The machinery sector which serves the Australian potato industry is not large enough to embark on some of the higher risk areas of technology development and introduction, and is often faced with short term crises. It is important that the industry, through bodies such as HRDC, address the issue of availability of adequate resources for technology introduction and development activities.

STUDY TOUR REPORT

3 - 23 September, 1994

OVERVIEW OF TRIP

The primary purpose of the trip was to attend Harvest '94, a large exhibition and demonstration of potato production technology organised by the Potato Marketing Board (PMB) of the United Kingdom. A visit was also made to the Scottish Centre for Agricultural Engineering to view research developments in harvester technology and re-new contacts with researchers. At the request of HRDC, the Scottish Agricultural College at Aberdeen was visited to view and discuss developments in potato storage. Through researchers at SAC, Aberdeen, contacts were also established with Proctor Ltd. and Wedderspoon Processes Ltd., companies involved in the supply of environmental control equipment for potato storage.

A short time was spent in Idaho and Michigan in the US en route to the UK. Expenses for this part of the trip were funded by a private company (Dobson's Vegetable Machinery) to enable me to inspect a number of facets of potato production, but particularly to undertake familiarisation training with instrumented sphere technology in Michigan. While in Idaho, a visit was made to the University of Idaho research station at Aberdeen to view engineering work related to potatoes and to establish new contacts.

GENERAL COMMENTS

The opportunity to view first hand some of the practices and research in the major potato growing areas of the western United States was welcomed. The visit to the PMB harvest exhibition was a good opportunity to see the most recent developments in potato industry technology gathered together in one place. It also re-confirmed that, due to similarities in climate, soil type and the scale of operations, the first preference when looking at overseas advances in potato production technology should be Europe and the UK. This comment is particularly relevant to the Tasmanian industry and other sectors of the Australian industry which have similar constraints as a result of topography or size of operation. Many of the factors which influence potato industry operations in the major US potato production regions are not relevant to many parts of the Australian industry, so the technologies and practices are sometimes more difficult to transfer. That is not to say that we should ignore what develops in the US with regard to individual pieces of technology. We should always be on the lookout for advances which will help the industry regardless of where they originate. However, if we are looking for system type advances, the technology available in the UK and Europe provides a more easily adaptable framework from which to begin.

It would be hard to find a better collection of the range of technologies available to the potato industry than the PMB demonstration and exhibition. I would recommend that the potato industry should always be represented at future events, which occur about every 18 months. Although it was not planned this way at the time of the original

proposal, I was accompanied on the trip by the owner of a machinery manufacturing and importing business and a grower. The different perspectives offered from the R&D, machinery and production sectors greatly increased the value of the trip. I would recommend that similar trips in future, particularly to events like the PMB demonstration, should have a similar representation. The most obvious addition to expand the perspectives of the group would be a field officer representative from the processing sector.

Harvest and storage were the two primary topics of interest on this trip. Other points of general interest were also pursued, and the following report deals with each area by topic.

HARVEST

Idaho

Researchers at the University of Idaho, Aberdeen, are developing an automatic boom control for harvesters and pilers. The controller uses an ultrasonic sensor which measures the distance between the end of the boom and the surface of the pile of potatoes, and controls the position of the boom within a pre-defined band of distance from the pile. The sensor appears to be superior to other systems that have been used in the past, many of which were based on infra-red technology. There don't appear to be any boom control systems factory fitted to harvesters in the US, and only two harvesters at the PMB demonstration in the UK offered automatic boom control as an option. This is surprising, given the emphasis that has been placed on tuber damage reduction, and the need to minimise drops, in recent years.

Michigan

A visit was made to Techmark, the manufacturers of the IS100 instrumented sphere, to observe its performance in a harvester assessment and to gain familiarity with its use. The IS100 is a very "user-friendly" piece of equipment which can be used to assess the damage potential of machinery such as harvesters and graders. Dobmac Vegetable Machinery (Ulverstone, Tasmania) have purchased an IS100 which will be available for hire for extension and research work.

Harvest '94, PMB demonstration and exhibition

Harvest '94 was held at Acaster Malbis, in Yorkshire, on September 14-15th. Although the emphasis of the exhibition was on harvest, grading and handling technology, equipment dealing with seed production, tillage, planting, crop monitoring, irrigation, spraying and storage was also represented.

All of the active demonstrations were associated with harvest, field transport and grading, and the exhibition was an excellent opportunity to observe different harvesters in operation. Of particular interest were the low profile twin row harvesters which dominate the European and UK potato industry. This style of harvester is used in some parts of mainland Australia, but has yet to be adopted in the Tasmanian industry. There were 13 harvesters of this style from 6 different manufacturers at the demonstration. There were two single row machines present, and a few twin and four row harvesters of different design. All but one of the low profile twin row harvesters had clod separation rollers of the type originally manufactured by Dahlman, and now offered by a range of companies including Lockwood, Standen, Reekie, Grimme and Kverneland.

The twin row harvest system is based around a relatively light weight harvester which is usually, but not always, unmanned. The harvester lifts the potatoes and separates out most of the dirt and rubbish. Haulm is usually dealt with by a combination of haulm toppers mounted on the front of the tractor and stripper rollers in the harvester. As the potatoes flow through the machine in the direction of travel, they pass over two webs and a clod separation system, before being fed onto an outloading elevator. This conveys the potatoes to a chaser bin which is towed by another tractor travelling beside the harvester. The feed onto the outloading elevator is the only direction change

experienced by the potatoes. Potatoes are taken from the paddock in the chaser bin for final cleaning and grading.

Cheaper and faster harvest is one of the potential benefits of the twin row system compared to the single row system currently used in the Tasmanian industry. Faster harvest rates are achieved because two rows are lifted together, and the speed of operation is not limited by having people working on the back of the machine to do the grading, which is a common limitation to harvest rate in the existing single row system. Reducing operating cost, and being able to harvest more tonnes in the same time will help towards reducing harvest costs. Admittedly, extra equipment, such as chaser bins and a grader, is needed to operate the twin-row system, and this increases the capital cost of the harvest system. However, even with the associated equipment, the system should be cheaper than two single row machines of equivalent capacity.

Another common criticism of the system is the need for extra handling into and out of chaser bins and over grading systems. There are no more potential impacts in the actual harvest operation with a twin row machine than there are with the existing single row system. The only extra handling required is over the grading system, and while it is true that extra handling exposes tubers to greater risks of damage, the equipment and techniques exist to do this job gently and without damaging impacts.

A common argument against twin row systems that use chaser bins is that they cause more soil compaction. This is generally not the case. A twin row unmanned harvester has considerably lighter axle loadings than a single row machine fitted with a bunker. Axle loading is the main factor influencing deep soil compaction which is virtually impossible to remove with tillage. The other important aspect with regard to soil compaction is the choice of chaser bin. Soil compaction will definitely be a problem if 10 or 15 t trucks are used as chaser bins. Chaser bins should be tractor drawn, preferably be fitted with low ground pressure tyres, and have a capacity of 6 to 8t.

A number of tractor drawn trailers were represented at the exhibition. These are widely used in general agriculture in Europe and the UK, and are the dominant means of transporting potatoes from the harvester to grading plants, storage or other transport. One trailer of particular interest featured rubber tracks to reduce ground pressures and help reduce soil compaction. However, there would still be a need to ensure that axle loads were low enough to avoid deep soil compaction.

The twin row harvest system as used in the UK and Europe will not necessarily be the right system for everyone or all conditions. However, given the importance of harvest in the overall cost structure of potato production, it is a system which certainly deserves serious consideration by the local industry from the viewpoint of on-farm operations and the logistics of product supply to the processors.

Other harvest equipment seen in operation at the demonstration included a fully hydrostatic twin row harvester, the Thomas C-91. This machine has been in use for a few years, and was the only fully hydraulic harvester at the demonstration. Use of hydraulics as the only power source is often avoided in agricultural machinery, partly

because of the additional expertise needed to carry out in-field and on-farm troubleshooting and repairs. However, using hydraulics as a power source does pave the way for future developments in automatic control systems, such as control of web speeds with respect to ground speed or loading condition.

Also on display were two self-propelled harvesters, one two row and the other four row. These machines are gaining some popularity in Europe, but do not seem to have gained much favour in other areas at present. An operator would require large annual throughputs to justify the capital cost of these machines, and the digging, separating and conveying technology used doesn't appear to offer any advantage over that which is available in the smaller twin row machines. A manned twin row fully offset trailed harvester was also demonstrated. It was fitted with an outloading conveyor to suit chaser bin operation, but it is apparently also available with a bunker. Deep soil compaction resulting from high axle loads would be a probable down side of this type of harvester, given that total machine weight would be in excess of 11 t when fully loaded.

Scottish Centre for Agricultural Engineering

A visit was made to the Scottish Centre for Agricultural Engineering to inspect and discuss developments regarding the 'Pulsar' harvester. This harvester has been used as a working proto-type for about 3 years, but efforts to commercialise the design have not yet been successful. While there is general recognition of the many innovative design features in the 'Pulsar', it has to undergo a critical phase of development before it could be produced as a commercial model. It has to be changed from a prototype to a production model, which basically involves the incorporation of stock items from the inventory of whichever manufacturer takes it on, and then gearing up to manufacture those items which are not readily available. It appears that the industry in Europe and the UK is not currently prepared to take on that task. It is more likely that some of the individual ideas incorporated in the 'Pulsar' will find their way into commercial machines in future models. The most innovative features in the 'Pulsar' are the use of rotary digging shares for reduced draft and tuber damage, hollow rod webs for reduced tuber damage, and horizontal agitation of the digging web for improved soil separation and reduced tuber damage.

Another feature which could find fairly ready acceptance is a removable "step" which can be used in the digging web. The transfer from one web to another can improve soil separation because the drop breaks up the flow of material. The step is achieved by feeding the web around two adjustable idlers to create a drop. When not needed, the step can be removed and the slack in the web taken up by idlers on the return leg (Figure 1).

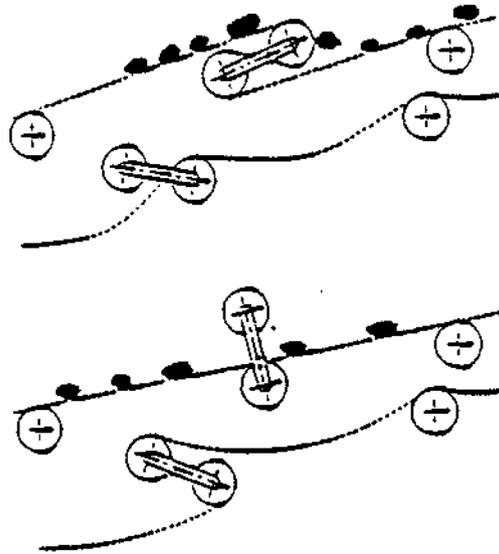


Figure 1. A removable step in the digging web will allow an extra drop when needed for improved dirt removal (top) and reduced damage when it is not needed (bottom).

Recommendations

The twin row harvest system as used in the UK and Europe should be investigated for adoption in the Tasmanian industry. The first step of this will be a basic economic analysis, which it is intended will be conducted over the next few months.

The potato industry should ensure that a small group representing all sectors of the industry (growers, processors, machinery firms and R&D) should regularly attend functions like the PMB demonstrations in order to remain in touch with new developments occurring overseas.

STORAGE

Harvest '94, PMB demonstration and exhibition

A wide range of environment control systems for potato storages was shown. Most included features for control of temperature, relative humidity and duration of fan operation based on comparisons of conditions in the pile and ambient conditions. Many systems were used in conjunction with conditioning of the air, such as humidification or refrigeration.

Control technology displayed at the PMB expo and distributed by Fancom (Holland), has facilities to select pre-programmed storage regimes to provide conditions for drying, suberisation, cooling, holding and warming. The manufacturer claims that the system can control temperature to within 1°C and hold relative humidity at 95%.

One product at the simpler end of the technological range was a quilt for placing on the top of stored potatoes in place of straw, which has often been used as a protective and insulating barrier, particularly in smaller, less sophisticated stores. The quilt is a light weight synthetic, permeable to air and water vapour, but also water absorbent. This makes it suitable for the control of condensation in the top of the pile, and also for preventing greening. Quilts of this type may have a role to play in "low-tech" on farm stores. A visit to a farm showed that straw bales are still used for wall insulation in smaller scale stores. In addition, this particular store was using a specially made flat straw 'bale' to cover the pile after loading was completed.

Scottish Agricultural College, Aberdeen, Proctor Ltd. and Wedderspoon Processes Ltd.

The Scottish potato industry is largely involved with seed production for whole round seed, and storage is almost exclusively in 1 t boxes, even in situations where large volumes of ware potatoes are handled. A visit was made to one farm and packing operation which handled 20,000 t of ware potatoes, in addition to its seed crop, entirely in 1 t boxes.

Box construction

Potato boxes in the UK are now made according to the British Standard (BS 7611:1992). This standard specifies certain loading test that boxes must be able to withstand, although no particular methods of box construction are mandated. Boxes are rated for a maximum stacking height of 4, 6 or 8 boxes. The most common method of construction seen used internal diagonal timber bracing to prevent racking, while another design used external "gang-nail" strips fitted vertically at the mid-point of the long sides of the box. All internal fittings are chamfered to minimise tuber damage from sharp edges and tuber retention during tipping. Box walls are fully closed by mounting boards edge to edge, rather than leaving a gap as is common in many boxes used in Australia. This helps with the strength of the box, but also prevents air leakage when positive ventilation systems are used.

In-store ventilation systems

Both ambient and refrigerated ventilation systems are in use in the Scottish industry. It is quite possible to store potatoes until early spring without refrigeration, provided insulation, positive ventilation and control of the ventilation system is provided.

Many seed potato stores use refrigeration for cooling. Refrigerated air is pumped into the head space of the store at the rate of 20-30 l/s/m³ (50-70 m³/h/t) of stored product, and distribution of the air through the store is achieved by the cold air falling through the stacks of boxes and being drawn back along the floor to the cooling unit. Air mixing and frost protection controls are normally used.

There is a school of thought which suggests that relative humidity control is less important than has been considered in the past. Research is showing that even very low levels of surface moisture (lower than are visible to the human eye) can lead to losses from storage rots. Further, tubers that have become very slightly dehydrated are less susceptible to damage during handling and grading out of store than those which are turgid. It is generally considered that the shrinkage losses incurred (5-6%) are of less value than the potential losses due to disease or damage by maintaining high levels of humidity. The refrigerated ventilation systems used tend to supply air at about 80% relative humidity, while the humidity in ambient systems is weather dependent. To some extent, the jury is still out on this issue, but the slight tuber dehydration is probably worth the lower risks of disease and tuber damage in the whole seed industry, since seed is increasingly being sold by count rather than weight, and the lower levels of disease organisms in storage would be beneficial for reducing seed breakdown after planting.

Work at SAC has shown the benefits of positive ventilation with either ambient or refrigerated storage systems. These use fans and ducting to ensure that air passes through the tubers stored in the box, and does not merely short circuit the stack back to the fan. All of the positive ventilation systems in box storage require good quality boxes and a fairly high degree of accuracy in stacking to minimise air leakage between the boxes.

The Posi-Vent[®] system consists of a small fan connected to a tapered canvas duct. Holes in the duct allow air to flow into the space between the top of one box and the bottom of the next in a stack. Each duct serves two layers of boxes and are mounted to supply air downwards into one layer and upwards into the next layer (Figure 2). The layer that air is supplied to is blocked at the opposite end, and the open spaces above and below the supply layer exhaust the air. The flow rate supplied to the potatoes is about 60 l/s/m³ (140 m³/h/t) after leakage losses. The system can also be used for warming potatoes before grading by mounting a heater at the intake. This has particular application for reducing impact damage during grading of seed and fresh market potatoes in the Scottish industry. This system is a development of the "letter-box" design which has been used for some years.

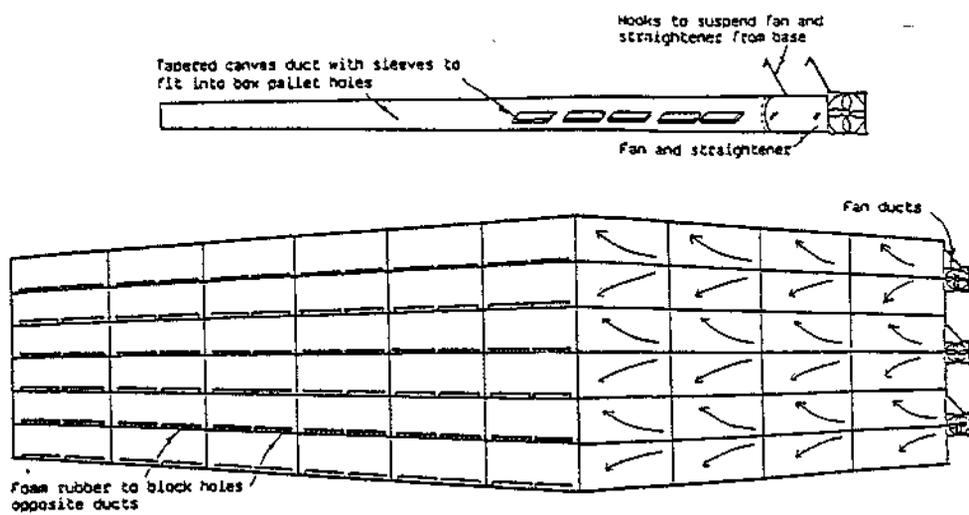


Figure 2 Schematic diagram of the Posi-Vent system showing directions of airflow through boxes of potatoes.

A further development of the Posi-Vent® system is the Posi-Igloo™ (Figure 3). This includes an insulated "tent" that is supported from the shed roof and hung over the stack of boxes. The Posi-Vent® fan and duct system supplies refrigerated air, which can be a mix of return and fresh air. This system provides a low cost alternative to purpose built cool rooms and can be operated in part of an existing shed.

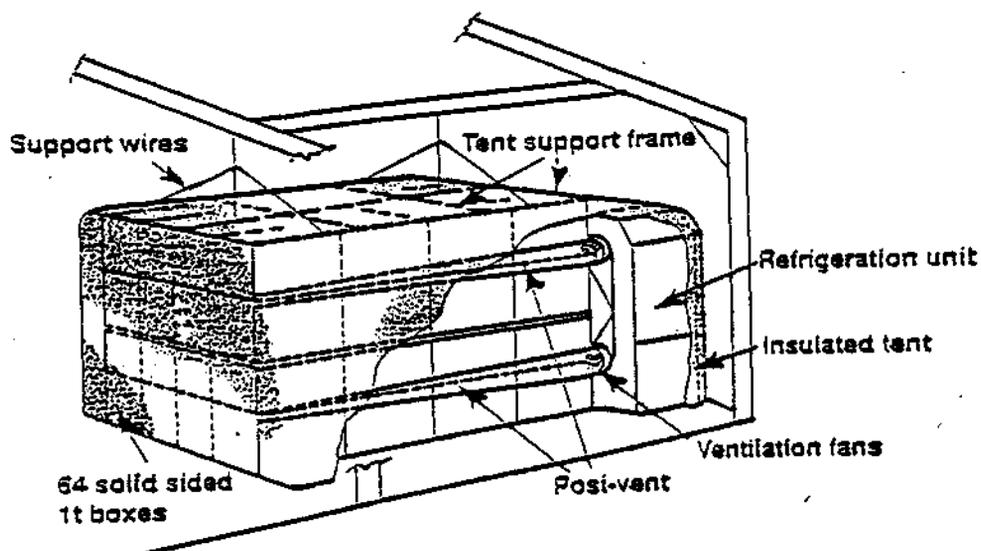


Figure 3 Schematic diagram of Posi-Igloo tent refrigeration system for box stored potatoes.

Another means of improving air distribution in box stores uses small fans hanging from the ceiling of the store. A fabric duct attached to the fan allows it to draw air from the

head space and deliver it to near the floor to improve on the circulation that is achieved by merely letting the air fall to the floor.

A very wet seed harvest some years ago led to the development of a drying tent. This is a polythene sleeve which fits over a stack of 36 x 1 t boxes. A fan mounted in the top of the sleeve draws air into the stack at the base and the sleeve is drawn onto the boxes by suction (Figure 4). Air flow rate is 70 l/s/m³ (170 m³/h/t). This system can also be used for warming potatoes. The capacity of the system could easily be increased for other applications.

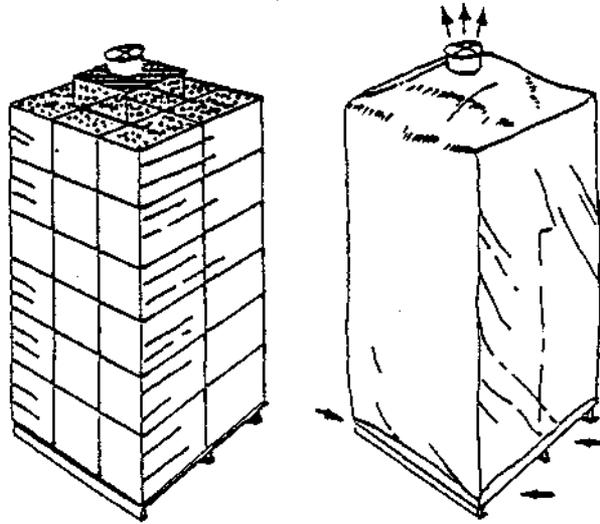


Figure 4 Schematic diagram of potato drying tent with and without the tent in place and showing the direction of airflow when in operation.

Recent research at SAC has led to the development of a "skin resistance sensor" for measuring the moisture level on the tuber surface. This has now been taken up by a private company with the idea of using the sensor as part of a control system so that air temperature and relative humidity, and duration of fan operation, can be selected to avoid condensation on the tuber surface.

Recommendations

The provision of more storage capacity, particularly in the Tasmanian industry, is critical to avoid winter harvest operations and its associated problems, such as soil degradation. It is important that the industry recognise that the technology required for storage can be relatively simple in cool, temperate climates, provided good management procedures are in place, and storage duration is limited to the cool, wet months. Every encouragement should be given to growers to establish short term storage facilities.

OTHER OBSERVATIONS AND COMMENTS

Tillage

Work done at the University of Idaho indicates that there are some advantages to be gained with respect to water uptake and erosion reduction by carrying out a subsoiling operation about 2 weeks after planting. The work was done using a bent shank subsoiling tyne, which allows the shank to travel between the rows while the tillage is done underneath the row. The tyne causes tensile failure of the soil and is therefore fairly energy efficient. The operation is done at a depth of 400-500 mm and leaves a U-shaped tillage zone. The reason for doing the operation after planting is that it relieves any build up of compaction which has occurred during tillage and planting operations. There is scope for including re-hilling and basin tillage in the operation. There is apparently an increasing interest in this type of operation in the UK industry, and a bent leg sub-soiler was exhibited at the PMB expo. It is logical that subsoiling should take place after planting so that it leaves the crop growth zone in the most friable state possible. Any wheel traffic which occurs after sub-soiling only serves to re-compact the soil.

Irrigation

Many of the irrigation systems in use in Idaho are centre pivots, along with some side roll and solid set systems. Centre pivots often use an end gun or guided trailing span to "fill in" the corner to get something approaching a square paddock out of a round one. Some growers use solid set irrigation in the corner. There was common agreement among growers and researchers that the yield under the "fill in" guns, as compared to that under the inner spans, was reduced by about 20-25%. This appears to be due to less uniform irrigation resulting from wind effects on the water spray from the gun, a problem which is thought to be prevalent in areas which use travelling gun irrigators. It is noted from irrigation studies done in Tasmania in 1989-91 that potato yield remained constant under lateral move and travelling gun irrigators, but that the lateral move was 15% more efficient in its water use.

There is a wide spread belief that centre pivot irrigation systems are suitable for use only in areas with large expanses of flat terrain. After observing some of the systems in use in Idaho, I am inclined to differ with this opinion. There were many systems operating on undulating (but not steep) land, and many are configured to irrigate irregular shaped areas. It is clear that the best economies of scale are obtained with large, circular pivots on relatively flat ground. However, there is no doubt that the technology will work in areas which do have undulating terrain. The unknown question regards the economics of such a system.

Likewise, a number of solid set irrigation systems were seen in use in Idaho. The improved application uniformity and (possible) yield benefits of such a system need to be assessed relative to its cost.

Crop monitoring

A blight risk monitor was displayed at Harvest '94 which is used to provide advice on the risk of blight infection in order to help with spray scheduling. The device monitors temperature and relative humidity and records the number of hours for which conditions above 10°C and 90% relative humidity exist. If more than 11 hours of such conditions are recorded in each of two consecutive 24 hour periods, a high risk period has occurred and preventative spraying is recommended.

Haulm destruction

Public pressure in Europe has led to a move away from chemical desiccation to mechanical haulm destruction for green potato crops. A Dutch hilling and haulm pulling system has advanced the development of this process. The system apparently requires fairly regular hill shape, so hilling machinery is used both before and after planting to establish conditions which are optimum for the use of the haulm puller later in the season. The haulm is flailed and then pulled in one operation. There is some evidence to suggest that the operation done with this particular machine reduces the incidence of disease infection of tubers during the skin set period.

Tuber damage assessment

The Scottish Centre for Agricultural Engineering is involved in a range of work associated with assessing tuber damage. Included in this is the development of a new damage index and a standardised test for bruising susceptibility using a "damage barrel". SCAE has produced, for a number of years now, "hot boxes" to accelerate the formation of black spot bruises in tubers. It is normal to allow 12 h for development of the bruise under "hot box" conditions. Recent work suggests that there is an orange discolouration which is a precursor to the development of the black spot bruise, and it may be possible to evaluate this for bruising damage in as little as four hours.

Another topic of interest to growers who harvest early or green crops is skin strength. Work at both SCAE and the University of Idaho is directed at developing reliable means for measuring skin strength. The SCAE work is in early days, but UI has a prototype device which measures the torque required to separate the skin from the underlying flesh. Work is continuing on this issue.

French fry design

SCAE has undertaken work to establish the best cross-sectional shape for French fries. Initial work indicates that hexagonal fries (Figure 5) have a number of benefits over square fries. Compared to a square fry, the hexagonal fry has a smaller surface area for the same cross-sectional area, and therefore absorbs 12-20% less oil. Waste appears to be reduced by 6-9% with hexagonal fries, and there are indications that cutting force is about 20% lower. Only time will tell where this will lead.

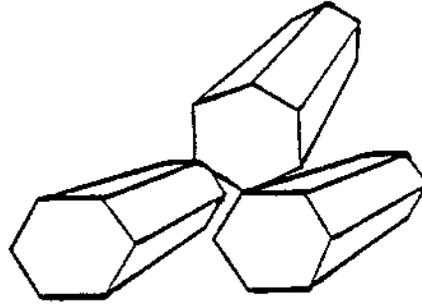


Figure 5 The hexagonal French fry - the shape of things to come?

Recommendations

The use of post-plant sub-soiling seems to be gaining some favour in other parts of the world. The use of bent-leg sub-soilers should be considered along with other tillage methods currently in use.

The improvements that appear to be possible with improved uniformity of irrigation application should be investigated, along with an economic study of different irrigation options, such as solid set and centre-pivot.

The suitability of the blight control monitor should be investigated in the context of current work regarding crop monitoring and spray scheduling.

Processors should consider the suitability of some of the techniques and equipment used in bruise assessment overseas in order to standardise the methods used in the Australian industry.

Mechanisms for improving technology transfer

The purpose of undertaking a trip of this nature is to observe recent advances in technology and make judgements about those which may be of use to the local industry. Depending on what is seen, recommendations are made for certain action to be undertaken. For this exercise to have any value to the local industry, the observations and ideas need to be communicated to growers. This is undertaken through meetings, the media and individual discussion. However, this will not necessarily be sufficient to bring about beneficial change or introduce new practices. Many new practices require investment in equipment, which can sometimes be quite expensive. Few growers are prepared to risk investment in equipment which is untried, or which may perform differently, under local conditions. Machinery firms often take a similar view. Furthermore, machinery firms often deal with a defined group of suppliers, and therefore access is not always available to the complete range of technology from overseas manufacturers.

The process of introduction and evaluation of new technologies can be expensive. Efforts to gain funding from bodies such as the Research and Development Corporations to undertake such work are often disadvantaged due to the cost. This is an issue that must be addressed by the entire industry if efforts to speed up technology transfer are to succeed.

There is a belief within the agricultural research industry that the development or transfer of machinery technology should be the role of the machinery industry. This view fails to recognise the reality of the Australian agricultural machinery industry. The small markets that exist in Australia for agricultural machinery make it difficult for the industry to justify expenditure in risk developments or technology importation. Furthermore, it is not only the individual machinery manufacturer or dealer who stands to gain from new technologies, but the producers themselves, who benefit from reduced costs or improved quality due to the adoption of new technologies. In the intensive horticultural industries, the ownership and operating costs of machinery represent up to 60% of the cost of production. This makes the issue of technological development an extremely important factor for the grower.

There is a technology transfer assistance program in operation in Canada which is worthy of consideration. The Farming for the Future On-Farm Demonstration Program is administered by the Alberta Agricultural Research Institute. It provides funds for projects that evaluate, adapt and demonstrate technologies that are used elsewhere in the country or world, but are not currently used locally. The program provides funding to assist a grower to obtain the necessary technology or implement the desired change. The bulk of the cost is met by the grower who retains ownership of equipment or infrastructure. In return for the financial assistance provided, the grower must agree to participate in a properly designed evaluation program which gives information on the success or otherwise of the change. Public demonstration of the technology is included in this process, thereby helping to speed up its transfer and adoption.

An advantage of the program is that it draws upon the resources available on-farm, such as tractors or buildings, resources which may have to be provided to each individual project in a more traditional type of R&D project. A program of this type could also support the further development and refinement of "farmer inventor" ideas, many of which languish due to insufficient resources for proper development. There is scope within the R&D Corporation structures to pursue this type of program and allocate funds accordingly. It may also be possible to draw additional financial support for such projects from the machinery industry.

Recommendations

The introduction of new technology to horticulture is as important to its future viability as R&D in other production aspects. It is important that the industry consider mechanisms for increasing the funds available for technology transfer.

LITERATURE AVAILABLE

Potato damage barrel
A new damage index
Mini hot box bruise accelerator
Fast bruise development
Skin strength in potatoes
Positive versus natural ventilation of boxes
Potato warming systems for reducing grader damage
Refrigeration of seed potato storage
Seed potato store management
Condensation on potatoes in box stores
Storage systems for seed potatoes
Positive ventilation for potatoes in boxes
New ventilation system for potatoes in pallet boxes
Posi-Igloo - a low cost, refrigerated seed potato store
Harvester design - getting into step for more sieving, getting out of step for less damage
New approaches to haulm destruction
Hitting the target with fungicides
Deep tillage effects on potato yield and quality
Zoned tillage for potato production
Abrasive peeler improvements
The slimmer's chip

ITINERARY

Saturday, 3 September

Travel Devonport, Melbourne, Los Angeles, Salt Lake City, Pocatello.

Monday, 5 September

Visits to farms in the American Falls, Pocatello, Blackfoot area.

Tuesday, 6 - Wednesday, 7 September

Visit to Idaho State University, Aberdeen, including visits to farms and manufacturers in the region. (Contact: Dr. J. L. Halerson)

Thursday, 8 September

Travel Pocatello, Salt Lake City, Cincinnati, Lansing.

Friday, 9 September

Visit to Techmark (Contact: T. Forbrush and K. Tinsey)

Sunday, 11 - Monday, 12 September

Travel Lansing, Detroit, London. Brief visit to Silsoe Research Institute.

Tuesday, 13 September

Visit to Standen Engineering, Ely and farms. (Contact: A. Bone)

Wednesday, 14 - Thursday, 15 September

Attend Harvest '94 at Acaster Malbis.

Friday, 16 September

Visit Scottish Centre for Agricultural Engineering, Penicuik. (Contact: D. McRae)

Monday, 19 September

Visit Scottish Agricultural College, Aberdeen. (Contact: Dr. S. Wale, Dr. P Burgess, R. Pringle)

Tuesday, 20 September

Visit Wedderspoon Processes Ltd. and Proctor Ltd., Forfar. (Contact: W. Wedderspoon, M. McLaughlin)

Wednesday, 21 - Friday 23 September

Travel Edinburgh, London, Hong Kong, Melbourne, Devonport.

Acknowledgements

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