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A Mechanical Harvester for Black Currants

In 1969 the Institute was invited by the Levin Horticultural Research Centre to take part in the development of a black currant harvester. The Centre had developed a method of growing the bushes in hedgerows which was considered to be admirably suited for mechanical harvesting, and a simple type of straddle machine had been already constructed at Levin. While this machine was mechanically limited, it had proved that the working principle was sound.

The general appearance and construction of the original machine and of the development models can be seen from the photograph. They consist basically of a tall frame on which the operator sits, some five feet off the ground. The front wheels are steerable and the rear wheels are chain driven from a $6\frac{1}{2}$ h.p. motor mounted behind the operator. A second motor of 6 h.p., provides power to energise the two finger wheels mounted on vertical shafts inside the frame. These finger wheels, which have a vibrating motion imposed on their rotation engage the branches of the black curant bushes and shake them vigorously, the fruit falling onto trays beneath. In action, the machine straddles each row in turn, moving slowly down the line of bushes.

The basic problem lay in providing a method of imparting the correct frequency of vibration to the finger wheels, superimposed on a rotary movement. The frequency must be high enough to be effective, but it must not communicate undue vibration to the machine as a whole. Unless the frequency is suitable picking is inefficient, while excessive vibration would make the machine unusable.



The harvester in operation. It straddles the row and picks from both sides at once.

Members of Institute staff including Mike Watson, Graham Garden and Dick Harwood, visited Levin to hold discussions with the staff and to work out the engineering specifications covering the mechanics of a machine which would basically perform the same operations in the same way as the Levin model. There were problems with the Levin machine in that the long vertical shafts carrying the finger-wheels were shaken horizontally. The finger wheels were left free to rotate, with the speed of rotation controlled by a simple braking device. Mechanically, this method of applying rotation and vibration to the finger wheels was not satisfactory.

It was finally decided to rotate the finger wheels positively with respect to ground speed and to superimpose the vibrating motion from a separate drive.

By the end of 1969 a simple vibrating mechanism superimposing its motion over the ground wheel drive had been worked out and a prototype was completed in time for testing during the black currant season.

Tests at Levin demonstrated that although the machine could pick black currants successfully, it was unsuitable mechanically for extended operation.

In the following year after considerable preliminary design work involving laboratory measurements to determine the forces present in the mechanism at various speeds, a better method of superimposing the necessary vibration on the rotating finger wheel was worked out. In the previous model a sufficiently high frequency could not be attained before far too much unbalanced vibration was transmitted to the entire machine. In the new design the drives are synchronous and contra-rotating. Although there is a greater degree of mechanical complexity this is justified by the excellent results. Now, with the two oscillator mechanisms balanced against each other, the machine can be used with finger vibrations as high as 1500 cycles a minute.

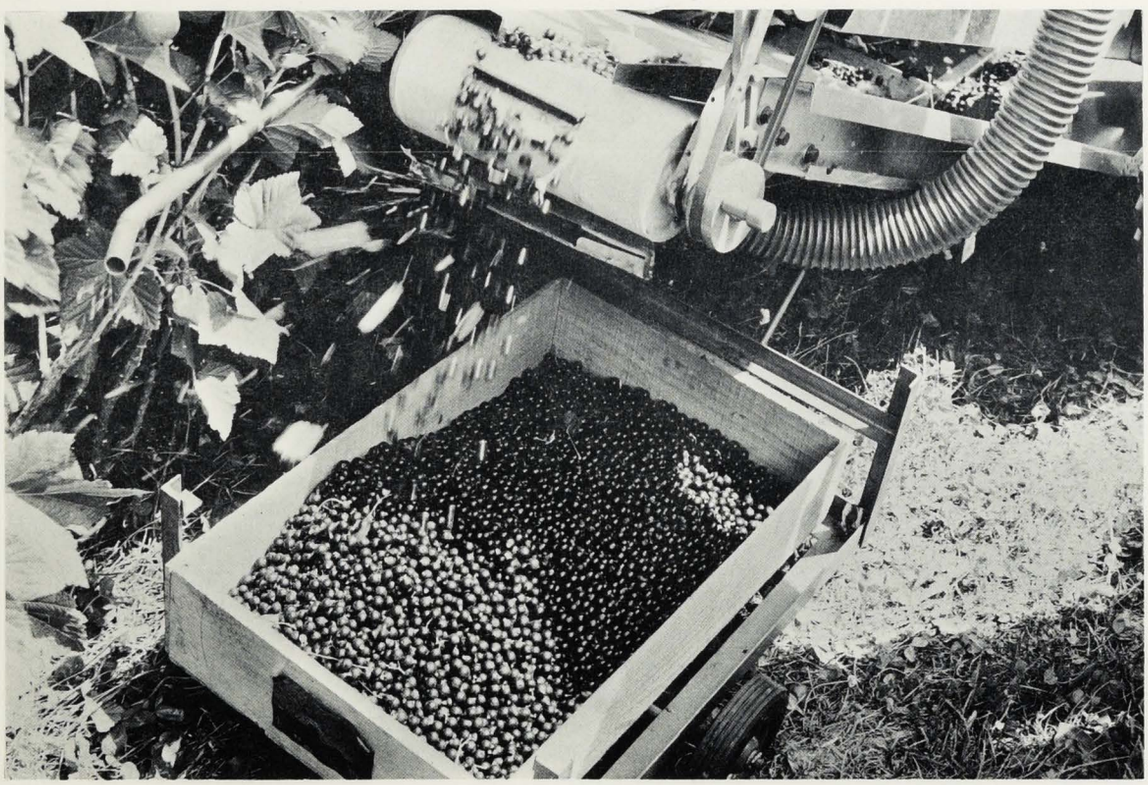
The construction of this machine involved considerably more than the assembly of components. Notably, the contra-rotating drive assembly could not be bought off the shelf because of its novelty. Detailed design as well as manufacture of the off-centre cam-operated vibrating heads was carried out by the workshop staff led by Dick Harwood.

In the summer of 1970 the completed machine was taken to Levin where the trials were very sucessful. On the basis of these the construction of a third machine was begun in 1971. This machine would be used as a prototype for any commercial production. The oscillatory mechanism was of a simpler design and vibration was cancelled in the gearbox. Other features which were added included a strengthened ground drive with larger diameter wheels, a transmission differential to facilitate turning and the incorporation of a reverse gear to improve manoeuvrability in confined areas.

Mechanisation of the picking process was carried through to provide a fruit conveyor system and a blower to remove trash. This addition completed the design and has been proved in the recent trials. The design of the conveyor system was not a simple matter. Besides working efficiently it had to meet Department of Health regulations concerning the materials used in construction and be simple to dismantle for cleaning.

A team of three is sufficient to operate the harvester — a drive — together with one man on each side to handle the full and empty fruit trays.

The machine stands almost 9ft high and is some 6ft wide and 13ft long. The total weight is 1900 lbs. The construction is based on two box section portal frames connected



Blackcurrants being delivered by the conveyor system to the boxes which are trailed by the machine.

longitudinally by other box section members.

The harvester can be operated at speeds of from $\frac{1}{2}$ to $1\frac{1}{2}$ mph and it has a turning circle of 26 ft. Headlands 18ft wide are sufficient space for the machine to manoeuvre in. A three speed gearbox provides a reverse and a maximum road speed of 7 mph. In transit the conveyor can be raised to give increased ground clearance.

Adjustments are easily made to cope with a wide range of picking conditions thus providing unusual flexibility. The finger-wheel and guide rails can be raised or lowered to suit the height of the bushes but most important, the amplitude and frequency of finger-wheel vibration can be set from the driver's seat over a range of 1 to 3 inches and up to 1500 cycles a minute respectively. This range of adjustment allows fruit to be picked selectively through to fully ripe. The rate of harvesting depends almost entirely on the density of the crop and the machine is capable of almost complete removal of fruit if desired, although it is usually preferable to pick only some part on each pass. On bushes in their second year of cropping $1\frac{1}{2}$ tons of fruit have been picked in two hours, leaving the remainder to be removed at the required stage of maturity.

Essential parts of the harvester have been patented and a limited number of machines will be made available to New Zealand growers at around $6000.



Blackcurrants picked by the harvester. The fruit is cleaner than it would be if hand-picked.

GRANULE APPLICATION BY HELICOPTER

Recently the team working on the problems of fertiliser spreading by ground machines received a request to measure the performance of a distribution system carried by a helicopter. If spreading was found to be satisfactory, such a system would have several advantages over both fixed wing aircraft and ground machines. In the first place, it is obvious that a helicopter can reach many areas which would be completely inaccessible to either tractor drawn or self propelled spreaders. Many of these areas could also make the operation of conventional aircraft extremely hazardous.

The system has already been extensively used in the northern half of the South Island prior to the Institute being asked to run performance tests on it, granules of a brushweed killing chemical being spread.

The method adopted to spread the granules is an extension of the use of the spinning disc which is employed on the majority of ground spreading machines in use in New Zealand. The bin, which is in the shape of the familiar inverted cone, is suspended beneath the helicopter and the granules are gravity fed onto the spinning disc which is mounted immediately below. The disc is driven via a shaft passing through the hopper, at a speed of about 3000 rpm by a petrol motor mounted on the top of the bin, while the flow of material onto the disc is controlled by the pilot by means of an electrically driven valve. The bin and spinner are mounted within a three-legged framework which allows the bin to sit on the ground for loading while the helicopter remains hovering above.

In operation the spreader is slung beneath the helicopter on a wire rope. The granules are spread by the spinning disc as the helicopter passes slowly over the area to be treated. Because of the unique re-loading system, very little time is lost on turn-around and so large quantities of materials can be spread in a short time.

In an emergency a button on the control column of the helicopter can be used to jettison the whole contraption.

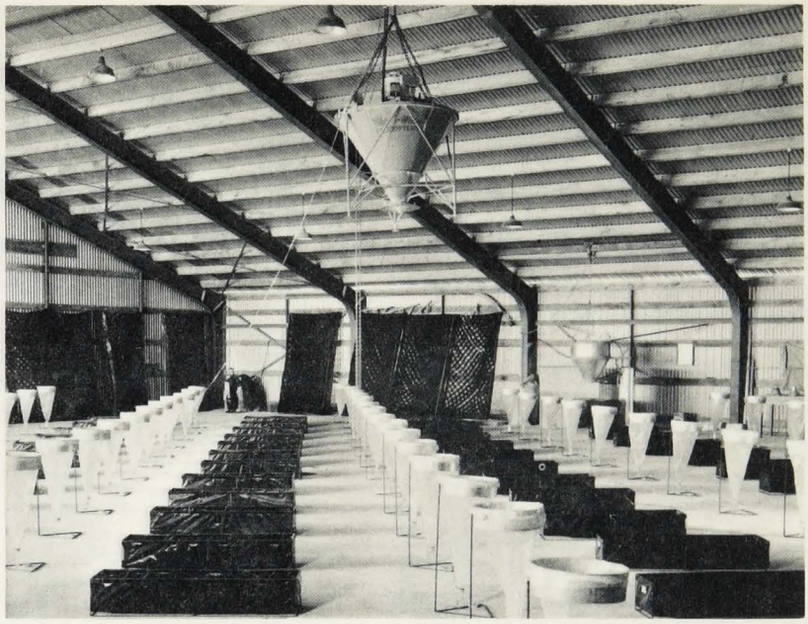
The tests so far carried out by Institute staff have been conducted in the Still Air Laboratory with the bin and spinner hung from the roof. As there was some doubt as to whether the trays which are used for collecting from ground spreading machines would operate satisfactorily, a number of inverted-cone shaped catchers were also set out. These were provided by the Invermay Agricultural Research Centre where they had been used in testing

the performance of spreading booms used by fixed wing aircraft. The tests however demonstrated that the shallow trays generally used caught virtually as much material as the deep inverted cones and that no special catching shape would be necessary. The doubt arose from the fact that the existing trays had been designed to catch material spread more or less horizontally while in this case the material would be arriving almost vertically and could have a greater tendency to bounce out.

To check on the recovery rate of material advantage is being taken of a computer programme originally drawn up by Walter Boughton and modified by Dave Painter for use in the testing of irrigation sprinklers. The suspended spreader threw a circular pattern in the same way as a sprinkler and the material collected by the trays was equivalent to the water caught in the calibrated cans. Using the computer programme contours of spreading density can be produced and these will show how much of the material leaving the spinner is recovered from the area covered by the catching trays.

Tests made so far indicate that the distribution pattern is good. However, in operation, the spreader would be subject to the down wash generated by the helicopter blades and this could have a significant effect on the spreading pattern. Field tests would have to be carried out and the results then compared with those obtained in the Still Air Laboratory to ascertain this. Any flight tests would be made at three different heights of which the lowest would probably be about eight feet.

This method of spreading fertiliser could have a number of advantages if the performance of the system measures up to expectations, particularly on difficult or isolated country.



The set-up for measuring granule application by helicopter. The bin and spinner (minus the helicopter) are slung from the roof above the lay-out of standard and conical catching trays.

Monitoring Commercial Aerial Spraying Methods

The New Zealand Agricultural Engineering Institute is carrying out research this year into methods of evaluating the performance of aircraft spraying systems taking into account both the operation of the system and the effects of the weather. Using these methods the Institute hopes to be able to determine the extreme limits of climatic conditions for the practicable operation of any particular spraying system. It is also hoped to develop equipment which operators can use in the field to monitor local weather conditions and to assess the quality of the job.

With this information the operators would be able to decide on the spot the best settings and techniques for the conditions at the time. They would also be able to estimate when conditions preclude useful results. This should result in better aircraft utilisation.

A spray droplet leaving a nozzle on an aircraft is subjected to a number of influences before it reaches the ground — if indeed it does reach the ground. There are the effects of aircraft slipstream, drift caused by wind, updraft currents of air and evaporation.

Under certain weather conditions droplets of a size small enough to be biologically desirable will often evaporate before reaching the target. This makes for conflict between the most desirable droplet size weatherwise which can be relatively large, and the biologically effective droplets which are often no more than a fine mist.

Permanent test facilities will be set up later by the Institute where modified or new spray systems or materials can be tested and related to operating conditions. A calibration service establishing swath width and distributing patterns is also to be established.

Work on the research programme began some months ago with the redesign and rebuild of the microclimate measuring equipment to make it more portable and more reliable. The design and construction of a droplet generator was begun, to be followed by experiments to established procedures for measuring the size of droplets and calibrating the associated sample cards.

The heart of the programme is of course the monitoring of spraying runs in the field.

The flight tests took place throughout the month of November of last year in the Rotorua area when large scale forests spraying was in progress. The research team recorded the spray patterns and prevailing meteorological conditions over some 50 runs before returning to Lincoln where the results are being analysed before being put to use.

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