A Proposed System for Once-over Machine Harvesting of Strawberries for Fresh Use

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Abstract. A mechanized system for harvesting strawberries with minimal damage to fruit is proposed. Cultural requirements involve placing plastic or fiber mesh netting over the beds before growth of leaves and inflorescences begins, permitting leaves and fruit to develop above the netting. The prototype machine developed for the system mows off leaves, raises the netting, cuts off pedicels of fruit supported on the netting and delivers the fruit to a conveyor and bulk box before rolling up the netting for storage. The harvester is supported under and can readily be adapted to most conventional garden tractor designs. Observations on a small sample of fruit harvested by the machine suggest the possibility of a sizable reduction in amount of injury to fruit compared with earlier designs.

A primary problem in harvesting strawberries by machine has been the considerable amount of damage to fruit incurred in the picking process (1, 2). Although harvesting fruit for fresh market is the ultimate goal, current designs have shown promise primarily for harvesting strawberries for immediate processing. Principal emphasis has been placed on a stripping, scooping or vibrating action of various types of tines to remove fruit in a once-over operation, often resulting in fairly high percentages of unrecovered and damaged fruit (3). One recent design employing the vibrating teeth principle has, however, reduced visible damage to fruit to a maximum of 15% of recovered fruit (4).

In an attempt to minimize the amount of fruit damage while mechanically harvesting fruit for the fresh market, a system involving another principle is proposed and is the subject of a patent disclosure (5). Along with a new design, this system will also require changes in cultural practices. Flexible netting (preferably weather resistant plastic or polyethylene) is placed on the strawberry beds before new growth begins in spring. As growth resumes, leaves and fruit trusses grow through and develop above the netting. Some anticipated secondary benefits, depending on properties of the netting such as color, mesh size and strand size might be: 1) slightly reduced surface soil temperature and improved moisture retention, 2) reduction or elimination of the need for heavy mulch to keep fruit clean and 3) reduced erosion and splashing of soil onto fruit by heavy rains.

A diagrammatic sketch of the harvester depicting essential principles of operation is shown in Fig. 1, with features described below labeled a-k. Three-dimensional arrangement of the same features along with orientation of the machine in relation to the strawberry beds is shown in Fig. 2.

Fig. 1. A diagrammatic sketch of the strawberry harvester showing essential components: (a) leaf mower, (b) netting, (c) netting lifter arms, (d) lifter arm camshaft, (e) sickle mower blade, (f) upper netting roller, (g) conveyor, (h) blower, (i) air stream, (j) drive roller, (k) netting takeup roller.

Fig. 2. A diagrammatic sketch of the strawberry harvester, showing essential components and method of mounting under a garden tractor (not to scale): (a) leaf mower, (b) netting, (c) netting lifter arms, (d) lifter arm camshaft, (e) sickle mower blade, (f) upper netting roller, (g) conveyor, (h) blower, (i) drive roller, (k) netting takeup roller, (l) power drive shaft, (m) roller drive wheel.


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After removal of leaves by the mower (a), netting (b), previously placed on the bed with fruit supported on it is lifted by long triangular netting lifter arms (c), capped to facilitate entrance of the plates under the netting and also individually moved up and down by the lifter arm camshaft (d), to facilitate lifting of the netting as the machine moves under it. Slots at 3-inch intervals between plates permit entrance of the fruit pedicles, which are cut under the netting by an oscillating sickle mower blade (e). Fruit is then carried over the upper netting roller (f) and dropped onto a belted conveyor (g), which carries the fruit to a small bulk container at the side of the machine. Power for the operation of the sickle mower, lifter arm camshaft and conveyor is provided by a single shaft connected to the power take-off shaft on the tractor. A right-angle drive on the shaft transfers power by belt drive to the camshaft.

Debris and shredded leaves not blown to the side of the bed by the mower are removed by the use of a blower (h); an air stream (i), aimed across the fruit carries debris over the conveyor and off to the side of the machine. Mower drive is provided by a 12-volt electrical motor connected to the tractor electrical system.

The netting, after passing over the rollers, is pulled under the conveyor and to the rear netting takeup roller (k) where it is rolled up for storage, perhaps until the following fruiting period.

To maintain roller speed (netting pickup) equal to that of ground speed, power to the drive roller (j) is provided by a ground driven roller drive wheel (m). Fig. 2, with appropriate sprocket reduction. The ground wheel also drives the rear takeup roller through a spring-tension slip clutch which permits variable roll-up speed as the roll increases in size, without increasing tension or distorting the netting to the point of affecting action by the drive rollers at the front (f, j). The rear netting takeup roller is removable, permitting a full roll of netting to be removed and a new roll started quickly and easily.

Small wheels are attached at the front on each side of the machine to provide support. Height adjustment on the support wheels is provided by a slotted wheel hanger brace. The 1970 prototype machine supported under a “CUB LO BOY” tractor is shown in Fig. 3. Results from 1970 tests of the system indicate a no. of problems that require modification before further data on machine performance can be obtained.

Three netting types were tested: a) ½-inch mesh type No. 5 “Zendel” polyethylene, b) 3/4-inch mesh “Vexar” Garden Netting3 and c) 3/4-inch mesh “PDS 29” polypropylene sheeting. Flexibility of the “Zendel” and “Vexar” nettings permitted expanding leaves to lift the nettings requiring a wire loop at intervals to hold the netting in close contact with the soil before penetration of leaves and fruit trusses occurred. The ½-inch mesh (“Zendel”) netting did not permit proper leaf penetration, indicating that larger mesh sizes will be required to prevent net lifting by plants. The PDS mesh showed considerable promise as a support medium for the fruit; the more rigid structure of the 40 mil strand also permitted easier penetration of the machine lifter arms under the netting without catching on the lifter tips. From these and other observations, it was evident that an ideal netting for this application should have the following properties:

1. Firm fabric with sufficient flexibility to pass over 3-4 inch rollers.
2. Heavy strands (40 mil or greater) to reduce fruit bruising and cutting as net is lifted.
3. Mesh size in the range from 3/4 - 1 inch to permit emergence of leaves and inflorescences before full development occurs.
4. Capability of withstanding weathering and machine stress (maintaining flexibility and strength) for at least 3 fruiting seasons.

Fig. 3. 1970 prototype harvester mounted under Cub tractor.

Two problems in machine design were immediately evident in initial trials. First, a tendency of the netting to catch or shove forward on lifter arm tips was reduced by attaching long, tapered shoes to the tips of the arms. A second problem, slippage of netting on the rollers, can probably be eliminated by maintaining spring tension on the free-running upper roller. This feature will be incorporated in future trials. A small sample totalling 3.3 lb. of ‘Stoplight’ fruit harvested by the machine was assessed for obvious damage and percentages of overripe and green fruit. Preliminary observations suggest a sizable reduction in the amount of visible injury to fruit. Usable and half-green fruit from this sample held in storage at 33°F for 5 days remained in acceptable condition for fresh use, indicating little or no internal damage. A more extensive evaluation of fruit damage and percent fruit recovery, however, is planned and is essential before full potentials of the system can be adequately assessed.

Future work with this harvesting system will entail testing of other netting types for capability of withstanding machine stress and weathering. Present netting costs ranging from $100 - $60 per acre hopefully could be reduced on an annual basis by reuse for a minimum of 3 seasons. It seems likely, too, that further reductions in labor costs can be obtained by laying netting on the beds with conventional equipment used to apply plastic film mulches.

**Literature Cited**