Cross section of an upright lettuce plant. Cutter blade must pass through the ridge of soil left during cultivation.

CULTURAL PRACTICES

Affect Success of U. C. Lettuce Harvester

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Certain conditions resulting from tilling, bed shaping, planting, thinning, and cultivating practices may cause lettuce heads to develop off center—which leads the U. C. mechanical selective lettuce harvester to "believe" that the heads are not ready to harvest, or affects the harvester's ability to cut the heads accurately.

RECENT FIELD TRIALS with the machine developed by the University of California for the selective harvesting of head lettuce (see *California Agriculture*, April, 1964) indicate that certain cultural practices can cause the machine to reject heads as immature when they are actually ready for harvest. To be suitable for market, heads must be fairly firm but not excessively hard (at which point they are bitter tasting and more susceptible to discoloration). A plant will remain suitable for only four or five days. Usually, only 20 to 40% of the plants in a field are ready for harvest at any one time. Most fields must be harvested from two to four times.

Operation

The U. C. harvester tests the size and firmness of lettuce heads with a rubber belt—ground driven from the wheel. As soon as the belt is positioned on the head, a switch located just behind the first roller locks the belt in position by activating a clutch which prevents the belt from floating up and down. The back roller is slightly lower than the front one; and to pass over the lettuce heads, one of two things must happen: (1) if the head is not firm, the back roller just rides on over, leaving the head undisturbed, or (2) if the head is firm, it pushes up on the belt which is now locked and held by spring tension. This upward push closes a second switch, which signals a memory unit. The memory unit stores the signal sent by the selector until the selected head is in position to be cut. Then the memory unit sends a signal to activate the cutter. As the belt locks in position on top of a head large enough to harvest, resistance to deflection pressure "tells" the machine that the head should be cut.

Stem support essential

Sufficient resistance depends not only upon the internal firmness of the head, but also upon the nature of the support **under** the head. Rather than developing symmetrically above the stem as might be expected, heads frequently develop off center. As long as the head is well supported, this off-center development poses no problem to the selector. But if the line of force does not pass through the area of support of the head, the head may tend to roll when it is being tested. If this happens, an otherwise firm head may "feel" soft to the machine and be rejected.

Several practices, according to the observations reported here contribute to the development of heads which are difficult to test: first, some growers plant extremely close to the edge of the bed in order to have the plants close to water. As a result, the heads tend to roll over the edge when pushed down by the selector. Second, many growers use rounded or peaked beds, where soil salinity is a problem. Water movement carries the salts away from the plant row and concentrates them at the center of the bed. Rounded beds are often used in combination with wide-row spacings, which also cause heads to roll when being tested. Third, even when flat beds with wide shoulders are used, cultivation and fertilization practices may tear down the edge of the bed and leave the plants without adequate support.

These three conditions cause heads to grow fairly consistently on the side of the bed. While it does present a problem to the selector, some compensation can be made by changing the tension on the spring (or the firmness acceptable to the machine)—or by providing mechanical support for the plants.

CALIFORNIA AGRICULTURE
Progress Reports of Agricultural Research, published monthly by the University of California Division of Agricultural Sciences.

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Cross section of a lettuce plant which has developed off center. Force applied to top causes head to roll over the edge of the bed.

Crooked heads

Other conditions may result in similar off-center development of a few heads in a field where the plants are generally upright. Clods resting above a seed may cause the plant to develop asymmetrically. Soil removed from the bed by the thinner may leave a plant on a miniature hillside. Plants left poorly supported at thinning time may be twisted by winds and be left to become crooked heads. Plants crowded on one side tend to grow toward the open space.

All of these conditions, resulting from tilling, bed shaping, planting, thinning and cultivating practices, affect the accuracy of the mechanical selector. They also affect the ability of the harvester to cut the heads accurately.

Cutting height

Lettuce grows so close to the ground that very little room is left for errors in the height of cut. The cutting blade is positioned by a wheel on the center of the bed, and if clods or holes affect the height at which the knife is supported, or the height at which the plant is growing, errors in cutting may result. As long as the relationship of the plants to the bed is consistent, the harvester cuts with reasonable accuracy.

When heads are growing over the side of the bed, the stem must be cut below the ground surface to avoid slicing the sides of the heads. Or, when a ridge of soil is left along the edge of the bed by the cultivator, the cutter must pass through the soil in order to cut the plant at the correct height. A similar situation results when the plants grow in a trough formed by the planter as it presses into soft soil or by the cultivator as it loosens and lifts the soil on both sides of the plant row.

Soiled heads

Excess moisture, either in the soil or on the plants, causes soil particles, loosened by the cutter, to adhere to the harvested lettuce heads. In bulk handling, some of this soil sifts into the heads. It detracts from the general appearance of the heads, provides abrasives which damage the lettuce tissue, and carries microorganisms which cause disease.

The problem of soiled heads is minimized if upright heads are grown on flat or slightly crowned beds and if the soil surface and plant leaves are dry at the time of harvest.

Economical operations

Prior to the development of the selective mechanical lettuce harvester, a great deal of emphasis was placed on ways to increase the uniformity of lettuce maturity in order to permit determinate or once-over harvesting. This research should continue. While the present harvester does select and harvest only the mature heads and can be used repeatedly, the cost of harvesting per carton of lettuce depends primarily on the quantity of lettuce harvested per acre.

The percentage of plants in a lettuce field that can be harvested at any one time varies widely. Sometimes, only 10% can be harvested. Or, sometimes, as much as 80% can be cut at one time in some fields. Much of this variation is due to weather conditions or market acceptability of different grades of lettuce.

However, the uniform maturity required for most efficient mechanical harvesting is the aim of much current research on planting, irrigating, thinning, cultivating, and fertilizing practices. New varieties are also being sought which will mature more uniformly and reduce the cost of harvesting.

In the meantime, harvesting costs may also be reduced by accepting a wider range of maturity and marketing different grades of lettuce.

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University of California experimental lettuce harvester.