Designing Peppers for Mechanical Harvest

by Dale E. Marshall, agricultural engineer, USDA Agricultural Research Service

Considerable effort has been expended since 1965 to develop a mechanical harvester for many different types of peppers (Capsicum spp.). In 1965, Ernest Riggs of Las Cruces, N.M., was the first known person to attempt mechanical harvest of Capsicum peppers in the United States (Riggs, 1971). By 1967, bell peppers were being harvested mechanically in California with modified tomato harvesters. During the rest of the 1960s and 1970s, various designs were tested by California dehydrators, yet less than ten harvesters were used commercially.

1970s

- The University of Georgia tried a harvesting concept with twin and single assemblies, with single and double open-helixes¹ on pimientos, settling on a double design (Fullilove and Futral, 1972).
- The Agricultural Engineering Institute in Israel built a 2-row experimental harvester (Wolf and Alper, 1985).
- The U.S. Department of Agriculture (East Lansing, Mich.) expanded research on Georgia’s twin, double-open helix concept and judged the most satisfactory for harvesting a wide range of peppers (Marshall, 1979, 1981).
- Jim McClendon of Tulia, Texas, built two trailer-model harvesters using the twin, double open-helix concept (McClendon, 1981). Self-propelled models followed the

¹Twin = two counter-rotating assemblies; single = one rotating assembly; single open-helix = helical assembly consisting of one rod wound around a central shaft; double open-helix = helical assembly consisting of two rods wound around a central shaft, with helixes being equally spaced along the shaft.

Hand-harvesting chile may become a thing of the past as mechanical harvesting gains widespread use.

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next year. At least 27 McClendon harvesters were built through 1996. Boese Equipment Co. has the newest harvester with the twin, double open-helix design.

- At the Texas A & M Research and Extension station at Weslaco, Posselius and Valco (1985) successfully tested the concept of zone harvesting (harvesting horizontal layers in the lower, middle, and upper portion of a plant).

- In North Carolina, RJR Foods built rotary brush and finger stripper units with vacuum and pressure assist for very pungent, Bahamian peppers (Smith and Joyce, 1974). In Spain an inclined brush concept is being tested for harvesting peppers for dehydration (Palau and Torregrosa, 1995).

1980s

- Experimentation began using powered, oscillating, forced balance shakers (FBS) originally developed for harvesting tomatoes by Studer (1980). These once-over harvesting designs cut the plant at ground level.

- The University of Arizona, University of Florida, Louisiana State University, New Mexico State University, Rutgers University, University of Tennessee, Texas A & M, USDA-ARS (California), and USDA-ARS (Michigan) experimented with pepper harvest mechanization.

1990s

- There were no active projects for pepper mechanization.

In summary, over 225 concepts or harvesters are known to have been tested in Bulgaria, Canada, Hungary, Israel, Italy, Spain, the United States, and the former U.S.S.R. Approximately 30 principles have been evaluated. The open-helix principle is used in more than 25% of the harvesters—more than any other principle.

With the continued worldwide need for labor-saving production methods, research on mechanical pepper harvesting by manufacturers and processors continues. I project that by the year 2000, interest and usage of mechanical harvesting will increase significantly.

Ideal Plant Type for Mechanical Harvesting

Because at least 20 different types of peppers are grown commercially in the United States, it is rather difficult to describe an ideal plant type for mechanical harvesting because of the many variations between different types. This greatly complicates the challenge for a harvester designer. For maximum success, plant breeders must work cooperatively with harvester design engineers to develop the plant for the harvester and to design the harvester for the plant. Specifications for the "ideal" plant type might be generalized as follows:

- The plant should have an upright principal stem, such as in most jalapeños, New Mexican serranos, plant introduction cherry-types, and Spanish chile.

- The plants should not have a wide branch or crotch angle—like cherry or bell peppers—because they entrap and crush fruit and their branches may break off during harvest.

- The upright principal plant stems should be flexible and willowy, such as in some jalapeños and serranos.
• For plants not once-over harvested, it's easier if the plant is at least 600 mm high so the harvester conveyor can fit under the plant canopy.

• The branches should not have large nodes—such as found on cherry-type plants or bell plants—which frequently break off during harvesting.

• Crown set should be minimal.

• Pendant fruit are preferred to erect fruit, especially for inclined harvesters that strip up through the plant.

• Fruit detachment forces should be medium to low, such as those for jalapeño or sweet cherry.

• The root system must be well developed.

Special Considerations for Jalapeños

In the United States, many jalapeño processors require that peppers be de-stemmed, especially those used as either jalapeño rings or dices. To obtain de-stemmed peppers, the processors pay US$ 0.023 per kg for laborers to hand de-stem the jalapeños. Dillon (1981) tested concepts for de-stemming jalapeño peppers, but the principles have not been adopted by industry. Magrin manufactured a de-stemmer, but excessive mechanical wear and low throughput rates have stopped their manufacture and reduced their use. If either an improved design of de-stemmer or a reduced detachment force jalapeño pepper is developed, it would reduce harvesting costs, significantly reduce production costs, and expand the use of a mechanical harvester.

Cultural Aspects

Certain pepper types have been grown at increased plant populations obtaining increased plant height, yield per hectare, and harvestability. In 1980, average yield per plant generally decreased with decreased plant in-row spacing and yield per hectare increased with decreased plant in-row spacing for hot and sweet banana (table 1).

For four pepper types, in every case, yield per hectare increased and yield per plant decreased for 200 mm in-row spacings compared to 400 mm spacings (760 mm between rows): 2 percent and 89 percent for bell, 29 percent and 84 percent for hot cherry, 50 percent and 81 percent for Santa Fe Grande, and 75 percent and 78 percent for hot banana peppers, respectively (unpublished 1982 Michigan data by author).

Plant bushiness (volume of laterals) decreased and plant height increased with decreased in-row plant spacing.

For some mechanical harvesters on non-bed cultures, a 100 to 150 mm high ridge has been found to be useful. This aids in weed control and provides physical support to the principal plant stem to withstand side winds which may cause the plants to tip, lean, and lodge. It also aids in reducing plant uprooting problems.

The Future of Machine Harvesting

For the short term, selecting appropriate pepper types and decreasing in-row spacing could improve the ease of mechanical harvesting. Interest in mechanical harvesting in the 1990s in the United States has resumed with the trend towards decreased labor availability and increased minimum wage for hand harvesting the crop. Therefore, it is desirable to have improved pepper types that will be more suitable for mechanical harvesting. New interest in processing-type pepper breeding holds promise for the long term.

Mechanical harvesting experiments have been going on for more than 32 years, yet the process is still in its infancy. Mechanical pepper harvesting will become a reality because of the renewed interest in harvester development and improved pepper types that will be more suitable for mechanical harvesting. Worldwide

Table 1. Average yield/plant and yield/hectare for hot and sweet banana at five in-row spacings, with 760 mm row spacings. Ohio, 1980 (Marshall, 1981).

<table>
<thead>
<tr>
<th>In-row plant spacing (mm)</th>
<th>25</th>
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<th>150</th>
<th>300</th>
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<td>Hot pepper type</td>
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<td>Sweet pepper type</td>
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interest and use of mechanical harvesting is expected to increase significantly in the near future.

Note: A bibliography on mechanical harvesting of Capsicum peppers has been compiled (Marshall, 1996). For a limited time, it also is available directly from the author in MS-DOS computer floppy format.

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References


Corporate Member Profile: Chromtec

Chromtec was established by Marlin Bensinger in 1982. Located in North Beach, Fla., Chromtec employs three personnel and offers the following services to the chile industry worldwide:

Engineering. Chromtec provides consulting and engineering services to build or modify spice extraction plants worldwide, with special skills in producing chile heat and color. These services cover raw material selection and handling, drying, grinding, solvent handling, equipment selection, site selection, installation, and operation startup.

Analytical. Chromtec provides laboratory equipment installation service, personnel training, and analytical methodology for in-house analysis of spice products. Techniques include sample preparation, instrumental methods of analysis, lab and pilot plant extraction, and general lab techniques to comply with GMP and ISO certification.

Sales. Chromtec provides high quality, certified chile oleoresins to food, defense spray, and pharmaceutical markets. Each lot of material is analyzed in our U.S.-based lab and then guaranteed on the basis of that assay. Orders by the pound or by the ton are accepted.

For further information on Chromtec, contact Marlin Bensinger at (561) 625-8901, or e-mail at chromtec@aol.com.
Health Book Touts Chile's Benefits

Selene Yeager and the editors of Prevention Health books praise the health benefits of chile peppers in their book, New Foods for Healing. Capture the Powerful Cures of More Than 100 Common Foods—from Apricots and Bananas to Wine and Yogurt. In the section, “Chile Peppers—Red Hot Healers,” they write that chile is “more than just a little culinary spice” and that “these thermogenic morsels are prized around the globe for their healing power as well as their fire power.” They quote Irwin Ziment, professor of medicine at the University of California—Los Angeles, who says that hot chiles have long been used as natural remedies for coughs, colds, sinusitis, and bronchitis. They also quote Paul Bosland, Chile Pepper Institute director, who advocates adding 10 drops of hot-pepper sauce to a bowl of chicken soup. “Most of us here in New Mexico do this when we’re sick,” he says. “We all feel better after we’ve had a little bit of chile pepper.”

There is some evidence that chile peppers can help lower low-density lipoprotein (LDL) cholesterol—the type associated with stroke, high blood pressure, and heart disease. Chile also may ease the discomfort of psoriasis when applied as capsaicin cream; unblock clogged airways and reduce blood cholesterol; have a blood-thinning effect and hinder blood clot formation by increasing the time it takes for blood to coagulate; help prevent ulcers; and strengthen a person’s anti-aging arsenal, because they’re a rich source of the antioxidants vitamin C and beta-carotene (which is converted into vitamin A in the body).

“The hottest chile pepper isn’t necessarily the most healing, so don’t make yourself suffer” advise the authors.

The authors include recipes in the book and offer the following salsa recipe:

<table>
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<th>Fiery Chile Pepper Salsa</th>
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<tr>
<td>2 medium tomatoes, coarsely chopped</td>
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<td>2 small jalapeño peppers, cut in half lengthwise and very thinly sliced (wear plastic gloves when handling)</td>
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<td>1/4 cup minced red onions</td>
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<tr>
<td>2 Tbsp minced fresh cilantro</td>
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<tr>
<td>2 Tbsp freshly squeezed lime juice</td>
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<tr>
<td>1/8 tsp salt</td>
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</table>

Combine all ingredients in a small bowl. Mix well. Let the salsa stand for at least 30 minutes to allow the flavors to blend. Makes 1 1/3 cups.

Nutritional value per 1/3 cup:
- Calories: 29
- Total fat: 0.2 g
- Saturated fat: 0 g
- Cholesterol: 0 mg
- Sodium: 74 mg
- Dietary fiber: 0.8 g

“Hot Dates” to Remember

**September**
- 18–20: International Chile Pepper Expo, Fort Worth Convention Center; Fort Worth, Texas.
- 17–18: La Fiesta de los Chiles; Tucson, Ariz.

**October**
- 9–11: Florida Fiery Foods Show; St. Petersburg, Fla.
- 11–23: 2nd Annual Texas Fiery Foods Show; Seguine, Texas.
- 17–18: La Fiesta de los Chiles; Tucson, Ariz.

Mark your “chile calendars” for the following fiery events.

**August**
- 21–23: 2nd Annual Texas Fiery Foods Show; Seguine, Texas.
Come see the NMSU/CPI Demonstration Garden

If you are going to be in southern New Mexico in late summer or fall, come see the New Mexico State University chile breeding program’s Teaching and Demonstration Garden. The garden includes over 125 different varieties of chile and will be open Monday through Friday, 8 a.m. to 5 p.m. Literature about the garden is available.

Pepper Spray Attracts Bears

Jim Clarke, a writer for the Associated Press, recently reported that pepper spray made with capsaicin—most commonly used by hikers to ward off bears and other wild animals—can actually attract animals instead of repelling them. Clarke described one U.S. geological researcher’s experiment with bears in Anchorage, Alaska, as “500-pound cats with a ball of catnip.”

The researcher sprayed pepper spray on a rope lying on the beach near his observation point, then watched the bears come running. A camper in the area also reported problems with bears swarming his campsite after he sprayed around it with pepper spray.

Product researchers are saying that it is only effective if the spray is discharged into the eyes, mouth, or nose of a charging bear.

Watch for Pepper Diseases in Your Garden

Be on the lookout for pepper disorders in your garden this time of year. Blossom-end rot appears as water-soaked lesions on any side of the fruit near the blossom end. As the tissue dies, the area changes to a dark brown color, and eventually becomes black and leathery. Blossom-end rot is caused when the plant is unable to take up proper amounts of calcium for the fast-growing fruit. This usually happens when the plants are stressed for water. The best control is to maintain plant growth so plants do not become tall and leggy, while providing a good water supply during the hot, dry months.

Also watch for sunscald, which usually occurs in areas with bright, hot, sunny days. Larger fruits tend to be more susceptible, like pimientos, bells, and New Mexicans. The best prevention is to keep a well-developed canopy on your pepper plants. A large canopy helps to shade developing fruit from the hot sun’s damaging rays.

PLU Numbers not User-Friendly

Price Look-Up (PLU) stickers are creating problems for produce distributors. Many Florida vegetable shippers are losing the enthusiasm for sticking every fresh produce item with its own PLU number, says Tracy Russelle, assistant editor with The Packer.

Frank Pero, vice president of Pero Packing & Sales Inc. in Delary Beach, Fla., agrees. “A few customers want stickered peppers, but it’s less than 5 percent of our business.”

Sticking presents problems for shippers because of non-uniform pepper sizes. Pero says his company doesn’t even have a sticker for smaller peppers. Ben Litowich, president of Ben Litowich & Son Inc. in Pompano Beach, Fla., places PLU stickers on many items, but not on peppers. Tom O’Brien of C&D Fruit & Vegetable Co. Inc. in Bradenton, Fla., reports that his company is not set up to sticker large peppers. “It’s got to be done by hand.”

PLU’s are costly and are challenging to place mechanically. Mechanical placement of stickers often damages the produce. “We’ve got to satisfy our customers, but we have to find a better way of doing it,” says Alan Levy, president of Great American Farms, Inc. of Pompano Beach, Fla.

Question: I have about 15 different varieties of chile plants that have just sprouted from seeds. When they grow to the right size, I plan on transplanting the plants to pots or containers surrounding my outdoor deck. What is the best way for me to trim these plants in order to get compact, dense, high-yielding plants in containers?—George

Answer: Chile plants, like marigolds, zinnias, and snapdragons, can be pinched to produce a compact and dense plant. After the plants have developed three to four mature leaves—not cotyledons—the very top of the seedling can be pinched back to induce branching. At each leaf base is an axillary bud. The axillary bud will begin to grow, causing a more "branched" plant. These new branches will also have axillary buds at the leaf base. If the new branches are pinched, the axillary buds will begin to grow creating more branches. Usually, two or three "pinches" will produce a compact, dense plant.

Question: I live in Maui, approximately 2,000 feet elevation with abundant rain. I would like any information you can give me on what types of chile peppers could grow in this climate. I would like to grow my own to use in different types of cuisine and I've been told that some grow better in different climates. Any suggestions?—Robert

Answer: You're correct that some chiles will grow superbly in your area and others may not. The elevation isn't as important as day and night temperatures. All chiles do well in a climate that is 68–72°F during the day and night. However, some are more adapted to high temperatures and high humidity, for example, the habañero. Others, like the colored bell peppers, do best in a moderate to cool climate. The rain could be a limiting factor for you. Moist conditions are conducive to fungal and bacterial diseases. A soil that drains well is important. To find interesting chiles for your garden, try ones that originate from a wet climate.
Recently, a group of molecular biologists at the University of California–San Francisco Medical Center discovered, isolated, and cloned the elusive mammalian pain receptor. The pain receptor is a protein that binds capsaicin, activating a cascade of events in the sensory nerve that elicits the familiar burning sensation. This receptor is located on the surface of the mouth and skin of mammals. Birds, which evolved from dinosaurs, lack capsaicin receptors and can eat chile peppers with impunity. The pain receptor is activated by thermal stimulus (up to 45°C).

This discovery raises future hopes of a new, cheaper assay for capsaicin-used cloned receptor, and new capsaicin-like drugs for treatment of asthma, hay fever, arthritis, and chronic pain. The potential market for a drug like this is enormous.

*Source: Edward C. Greenleaf, M.D.*

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