Abstract: Companion planting is based on the idea that certain plants can benefit others when planted in near proximity. The scientific and traditional bases for these plant associations are discussed. A companion planting chart for common herbs, vegetables, and flowers is provided, as is a listing of literature resources for traditional companion planting. An appendix provides history, plant varieties, and planting designs for the Three Sisters, a traditional Native American companion planting practice.

By George Kuepper & Mardi Dodson
July 2001

Traditional Companion Planting

Companion planting can be described as the establishment of two or more plant species in close proximity so that some cultural benefit (pest control, higher yield, etc.) is derived. The concept embraces a number of strategies that increase the biodiversity of agroecosystems.

Generally, companion planting is thought of as a small-scale gardening practice. However, in this discussion the term is applied in its broadest sense to include applications to commercial horticultural and agronomic crops. ATTTRA has another publication, Intercropping Principles and Production Practices, that provides additional information on larger-scale applications.

While companion planting has a long history, the mechanisms of beneficial plant interaction have not always been well understood. Traditional recommendations (see summary chart provided as Table 1) used by gardeners have evolved from an interesting combination of historical observation, horticultural science, and a few unconventional sources. For example, some of the recommendations for companion planting, made around the middle of this century, were based on the results of sensitive crystallization tests (1).

Originally developed by Dr. Ehrenfried Pfeiffer, sensitive crystallization testing entails the mixing of plant extracts with select salt reagents like sodium sulfate or copper chloride. The resulting solution is placed in a controlled environment chamber and allowed to evaporate slowly. The process results in a precipitate that often takes on beautiful geometric forms and patterns. The characteristics of the pattern are studied and interpreted to establish whether the plants are likely to interact well with each other (1). Sensitive crystallization appeals to practitioners of Biodynamics™ (BD) and others who take a more metaphysical approach to nature. Conventional science is much more skeptical of this process as a means to evaluate plant associations.

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<td>Irish Potato, Cucumber, Corn, Strawberry, Celery, Summer Savory</td>
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<td>Dill</td>
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<td>Onion &amp; Cabbage Families, Tomato, Bush Beans, Nasturtium</td>
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<td>Irish Potato, Beans, English Pea, Pumpkin, Cucumber, Squash</td>
<td>Tomato</td>
</tr>
<tr>
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<td>Beans, Corn, English Pea, Sunflowers, Radish</td>
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</tr>
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<td>Lettuce</td>
<td>Carrot, Radish, Strawberry, Cucumber</td>
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</tr>
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<td>Beans, English Peas</td>
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<tr>
<td>Parsley</td>
<td>Tomato, Asparagus</td>
<td></td>
</tr>
<tr>
<td>Pea, English</td>
<td>Carrots, Radish, Turnip, Cucumber, Corn, Beans</td>
<td>Onion Family, Gladiolus, Irish Potato</td>
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<tr>
<td>Potato, Irish</td>
<td>Beans, Corn, Cabbage Family, Marigolds, Horseradish</td>
<td>Pumpkin, Squash, Tomato, Cucumber, Sunflower</td>
</tr>
<tr>
<td>Pumpkins</td>
<td>Corn, Marigold</td>
<td>Irish Potato</td>
</tr>
<tr>
<td>Radish</td>
<td>English Pea, Nasturtium, Lettuce, Cucumber</td>
<td>Hyssop</td>
</tr>
<tr>
<td>Spinach</td>
<td>Strawberry, Faba Bean</td>
<td></td>
</tr>
<tr>
<td>Squash</td>
<td>Nasturtium, Corn, Marigold</td>
<td>Irish Potato</td>
</tr>
<tr>
<td>Tomato</td>
<td>Onion Family, Nasturtium, Marigold, Asparagus, Carrot, Parsley, Cucumber</td>
<td>Irish Potato, Fennel, Cabbage Family</td>
</tr>
<tr>
<td>Turnip</td>
<td>English Pea</td>
<td>Irish Potato</td>
</tr>
</tbody>
</table>
The Scientific Foundations for Companion Planting

While conventional agriculturalists and BD practitioners may disagree over the validity of sensitive crystallization research, there is general agreement today on the validity of several mechanisms that create beneficial plant associations:

√ Trap cropping. Sometimes, a neighboring crop may be selected because it is more attractive to pests and serves to distract them from the main crop. An excellent example of this is the use of collards to draw the diamond back moth away from cabbage (2).

√ Symbiotic nitrogen fixation. Legumes—such as peas, beans, and clover—have the ability to fix atmospheric nitrogen for their own use and for the benefit of neighboring plants via symbiotic relationship with Rhizobium bacteria. Forage legumes, for example, are commonly seeded with grasses to reduce the need for nitrogen fertilizer. Likewise, beans are sometimes interplanted with corn. On request ATTRA can provide additional information on Rhizobium inoculation.

√ Biochemical pest suppression. Some plants exude chemicals from roots or aerial parts that suppress or repel pests and protect neighboring plants. The African marigold, for example, releases thiopene—a nematode repellent—making it a good companion for a number of garden crops. The manufacture and release of certain biochemicals is also a factor in plant antagonism. Allelochemicals such as juglone—found in black walnut—suppress the growth of a wide range of other plants, which often creates a problem in home horticulture. A positive use of plant allelopathy is the use of mow-killed grain rye as a mulch. The allelochemicals that leach from rye residue prevent weed germination but do not harm transplanted tomatoes, broccoli, or many other vegetables.

√ Physical spatial interactions. For example, tall-growing, sun-loving plants may share space with lower-growing, shade-tolerant species, resulting in higher total yields from the land. Spatial interaction can also yield pest control benefits. The diverse canopy resulting when corn is companion-planted with squash or pumpkins is believed to disorient the adult squash vine borer and protect the vining crop from this damaging pest. In turn, the presence of the prickly vines is said to discourage raccoons from ravaging the sweet corn.

√ Nurse cropping. Tall or dense-canopied plants may protect more vulnerable species through shading or by providing a windbreak. Nurse crops such as oats have long been used to help establish alfalfa and other forages by supplanting the more competitive weeds that would otherwise grow in their place. In many instances, nurse cropping is simply another form of physical-spatial interaction.

√ Beneficial habitats. Beneficial habitats—sometimes called refugia—are another type of companion plant interaction that has drawn considerable attention in recent years. The benefit is derived when companion plants provide a desirable environment for beneficial insects and other arthropods—especially those predatory and parasitic species which help to keep pest populations in check. Predators include ladybird beetles, lacewings, hover flies, mantids, robber flies, and non-insects such as spiders and predatory mites. Parasites include a wide range of fly and wasp species including tachinid flies, and Trichogramma and ichneumonid wasps. Agroecologists believe that by developing systems to include habitats that draw and sustain beneficial insects, the twin objectives of reducing both pest damage and pesticide use can be attained. For detailed information on establishing beneficial habitats, request the ATTRA publication Farmscaping to Enhance Biological Control.

√ Security through diversity. A more general mixing of various crops and varieties provides a degree of security to the grower. If pests or adverse conditions reduce or destroy a single crop or cultivar, others remain to produce some level of yield. Furthermore, the simple mixing of cultivars, as demonstrated with broccoli in University of California research, can reduce aphid infestation in a crop (3).
Options For System Design

Agronomists use the term “intercropping” to describe the spatial arrangements of companion planting systems. Intercropping systems range from mixed intercropping to large-scale strip intercropping. Mixed intercropping is commonly seen in traditional gardens where two or more crops are grown together without a distinct row formation. Strip intercropping is designed with two or more crops grown together in distinct rows to allow for mechanical crop production. No-till planting or transplanting into standing cover crops can be considered another form of intercropping. For more information on no-till planting, request the ATTRA publication Conservation Tillage.

References:


Resources:

Traditional Companion Planting

  Available online from Trafalgar Square Books for $24.95 plus $5 shipping and handling
  http://www.trafalgarsquarebooks.com

  Available for $15 plus $3 p&h from:
  Acres USA
  P.O. Box 91299
  Austin, TX 78709
  800-355-5313
  512-892-4448 Fax
  Email: info@acresusa.com

  Available for $13.56 plus $4.48 shipping and handling from:
  Amazon Books
  http://www.amazon.com/

  Contains an extensive companion planting chart.
  Available for $16.95 plus $4.50 p&h from:
  Bountiful Gardens
  18001 Shafer Ranch Rd.
  Willits, CA 95490-9626
  707-459-6410

Related ATTRA publications

- Intercropping Principles and Production Practices
- Farmscaping to Enhance Biological Control
- Introduction to Permaculture
- Biodynamic Farming & Compost Preparation
- Conservation Tillage

ATTRA// Companion Planting: Basic Concepts & Resources  Page 4
A fine general guide on organic growing that features a brief table of companion herbs and the pests they repel on page 48. A available for $18 plus $3 p&h from:
Acres USA
P.O. Box 91299
Austin, TX 78709
800-355-5313
512-892-4448 Fax
Email: info@acresusa.com

Contains both companion planting charts and a listing of insect repellent plants. A available for $14 plus $3 p&h from:
Acres USA
P.O. Box 91299
Austin, TX 78709
800-355-5313
512-892-4448 Fax
Email: info@acresusa.com

A available for $14.95 plus $4.50 p&h from:
Bountiful Gardens
18001 Shafer Ranch Rd.
Willits, CA 95490-9626
707-459-6410

A available for $11.96 plus $4.48 shipping and handling from: Amazon Books
http://www.amazon.com/

**Beneficial Habitats**

To avoid redundancy in our publications, anyone seeking further information on beneficial habitats is encouraged to request ATTRA’s publication titled Farmscaping to Enhance Biological Control. This publication also provides additional references for further research. Other ATTRA publications that might be helpful for designing and managing beneficial habitats include Biointensive Integrated Pest Management and Overview of Cover Crops and Green Manures.

**Intercropping Research**

ATTRA’s Intercropping Principles and Production Practices and Farmscaping to Enhance Biological Control publications are good sources for basic information on intercropping. The following publications should prove useful.

Provides a nice literature review of research to that time on intercropping, highlighting the multitude of factors causing variability in results.


An excellent synopsis of intercropping. The IPM Practitioner, published 10 times per year, is a benefit of membership in the Bio-Integral Resource Center (BIRC). Annual membership for individuals costs $35. Contact:
BIRC
P.O. Box 7414
Berkeley, CA 94707
Tel: 510-524-2567

**By George Kuepper & Mardi Dodson**
ATTRA Program Specialist & Project Intern, respectively
July 2001
Ancient Companions
An Appendix to Companion Planting: Basic Concepts & Resources
By Mardi Dodson

Introduction

For centuries, many Native American tribes throughout North America have cultivated corn, beans, and squash. The term “Three Sisters” was primarily used by the Iroquois who live in the Northeastern United States and Canada. These crops were considered to be special gifts from Great Spirit and were believed to be protected by the Three Sisters—spirits collectively called the De-o-ha-ko, meaning “our sustainers” or “those who support us” (1).

This ancient style of companion planting has played a key role in the survival of all people in North America. Grown together these crops are able to thrive and provide high-yield, high-quality crops with a minimal environmental impact. Corn, beans, and squash have a unique symbiotic relationship in a Native American garden. Corn offers a structure for the beans to climb. The beans, in turn, help to replenish the soil with nutrients. And the large leaves of squash and pumpkin vines provide living mulch that conserves water and provides weed control.

Corn

Corn is considered the most important of all Native American crops. Originating in South America and Mexico, corn was introduced during the Mississippian Period (600 A.D. to 1450 A.D.) to North American tribes via an intricate series of trade networks. Corn, beans, and squash combine to create a nearly perfect meal loaded with essential vitamins and minerals (2). In addition to its nutritional values, all Native American tribes that grew corn considered it a sacred and spiritually valuable plant.

Varieties

Choosing the right varieties of corn is essential to the success of a Three Sisters garden. The tall, sturdy heirloom varieties work best because they are most capable of supporting the beans. There are a number of Native American heirloom corn varieties to choose from. Traditionally, most of the corn grown
by Native Americans is dry field corn, which is used in flour production. Dry field corn is harvested late in the season when the ears have dried on the stalk.

Dry field corn is divided into three categories, dent, flint, and flour corns. Dent corns are adapted best to the Southeast and the Midwest. Dent corn has a distinctive dimple-like dent on top of the kernel when it is fully dried. A dent corn that grows well most anywhere in the United States is the Cherokee Blue and White of the Southeast. Reid’s Yellow Dent is also widely adapted. Bloody Butcher produces blood-red ears of corn on stalks that can reach from 10 to 12 feet (2, 3).

Flint corn grows best in the northern plains region. The kernels of flint corn do not shrink when they are dry. A popular flint corn is Indian Ornamental with colors ranging from purple to yellow. Two popular flint corn varieties are Fiesta and Little Jewels. Little Jewels is a unique, “mini” ornamental with four-inch-long, multi-colored ears and purple husks (3).

Flour corns usually have thinner-shelled kernels filled with soft white starch. Flour corns were developed in the arid Southwest. They are less likely to succeed in cooler northern regions with short growing seasons and in moist, humid areas where they are susceptible to a fatal rust disease. Hopi Pink is a short, drought-resistant corn, with kernels that range in color from cranberry to light pink. This variety has plump, thin-shelled kernels that grind easily into fine flour. A flour corn that works well in northern gardens is Mandan Bride. This variety is also drought-tolerant, with red, blue, yellow, pink, and purple spotted kernels (3).

Corn can be harvested earlier in the season when it is still “green corn.” Green corn is harvested when the corn is still in the “milk” stage, when the kernels are at their sweetest and can be eaten fresh. Varieties that are sweet when young are Blue Clarage, Bloody Butcher, and Black Mexican/Iroquois. Flour corns are usually not eaten in the green corn stage. Two exceptions to this rule are Anasazi and Mandan Red. (3). See Table 1.

### Table 1: Colorful Corn Varieties

<table>
<thead>
<tr>
<th>Variety</th>
<th>Type</th>
<th>Color</th>
<th>Can Be Eaten Fresh</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anasazi</td>
<td>Flour</td>
<td>Multi</td>
<td>✔✔✔✔</td>
<td>Ancient Southwestern variety, drought-tolerant</td>
</tr>
<tr>
<td>Beasley’s Red Dent</td>
<td>Dent</td>
<td>Red</td>
<td>✔</td>
<td>Heirloom from Indiana</td>
</tr>
<tr>
<td>Black Mexican/Iroquois</td>
<td>Sweet</td>
<td>Blue-Black</td>
<td>✔✔✔✔</td>
<td>Smaller variety from the Northeast</td>
</tr>
<tr>
<td>Black Aztec</td>
<td>Sweet</td>
<td>Blue, Black, Purple</td>
<td>✔✔✔✔</td>
<td>Originated from southern Mexico</td>
</tr>
<tr>
<td>Bloody Butcher</td>
<td>Dent</td>
<td>Red</td>
<td>✔</td>
<td>Northeastern United States, Virginia area</td>
</tr>
<tr>
<td>Blue Clarage</td>
<td>Dent</td>
<td>Blue</td>
<td>✔</td>
<td>Ohio/ West Virginia</td>
</tr>
<tr>
<td>Bronze-Orange</td>
<td>Sweet</td>
<td>Bronze-Orange</td>
<td>✔</td>
<td>Selected by Dr. Alan Kapuler</td>
</tr>
<tr>
<td>Cherokee Blue &amp; White</td>
<td>Dent</td>
<td>Blue and White</td>
<td>✔✔✔✔</td>
<td>Grown throughout North America</td>
</tr>
<tr>
<td>Cherokee White</td>
<td>Flour</td>
<td>White</td>
<td></td>
<td>Grows 12-15ft. Tall</td>
</tr>
<tr>
<td>Fiesta</td>
<td>Flint</td>
<td>Multi</td>
<td></td>
<td>Developed in New Hampshire</td>
</tr>
<tr>
<td>Hopi Pink</td>
<td>Flour</td>
<td>Pink</td>
<td></td>
<td>Short, drought-tolerant, Southwestern variety</td>
</tr>
<tr>
<td>Hickory King</td>
<td>Flour</td>
<td>Yellow</td>
<td></td>
<td>12 ft. tall heirloom</td>
</tr>
<tr>
<td>Indian Ornamental</td>
<td>Flint</td>
<td>Multi</td>
<td></td>
<td>Widely grown by North American Indians</td>
</tr>
<tr>
<td>Little Jewels</td>
<td>Flint</td>
<td>Multi</td>
<td>✔✔✔✔</td>
<td>4-inch-long corn developed in New Hampshire</td>
</tr>
<tr>
<td>Mandan Bride</td>
<td>Flour</td>
<td>Multi</td>
<td>✔</td>
<td>Originated from the Mandan tribe</td>
</tr>
<tr>
<td>Mandan Red</td>
<td>Flour</td>
<td>Reddish-Black</td>
<td>✔</td>
<td>Developed in Washington</td>
</tr>
<tr>
<td>Oaxaca Green</td>
<td>Dent</td>
<td>Green</td>
<td></td>
<td>Southern Mexico, makes green flour</td>
</tr>
<tr>
<td>Rainbow Inca</td>
<td>Sweet</td>
<td>Multi</td>
<td>✔</td>
<td>Developed by Dr. Alan Kapuler</td>
</tr>
<tr>
<td>Rainbow Indian</td>
<td>Flour</td>
<td>Multi</td>
<td></td>
<td>Developed by Dr. Alan Kapuler</td>
</tr>
<tr>
<td>Texas Honey June</td>
<td>Sweet</td>
<td>Yellow</td>
<td>✔</td>
<td>Heirloom, sturdy 7-8ft. Stalks</td>
</tr>
<tr>
<td>Tuscadorea/Iroquois White</td>
<td>Flour</td>
<td>White</td>
<td></td>
<td>Tall, Iroquois variety</td>
</tr>
</tbody>
</table>

*Adapted from Amazing Maize! Cultivate Colorful Crops by Eric Rosenthal (3).
Beans

Beans provide a high-quality protein food source that combines well nutritionally with corn. Beans also play a valuable role in the Three Sisters garden. Through a symbiotic relationship with rhizobium bacteria, beans help to take nitrogen from the air and convert it into a usable form for next year’s crop.

Varieties

Pole beans are best adapted to directly climb the corn stalk as opposed to sending runners across the ground. The Scarlet Runner variety is a popular heirloom pole bean that is famous for its large clusters of bright red flowers. Genuine Cornfield consistently produces in the heat of Southern summers. True Cranberry, a dark red bean with a meaty texture and a nutty chestnut-like flavor, also performs well in the South and in the Northeast. Cornfield, unrelated to Genuine Cornfield, does well in the Pacific Northwest because it matures before the fall rains come. A favorite in the arid Southwest is Hopi Purple, a purple bean with black crescent moon stripes.

Squash

Growing low to the ground, squash and pumpkin serve as living mulch. The large leaves block out much of the sunlight, thus reducing weed seed germination. Allelopathy may be an additional factor in weed suppression. Allelopathy refers to chemical secretions from a plant which have adverse or phytotoxic effects on some weed species.

Varieties

Most any variety of squash will work in a Three Sisters garden. In addition to the contemporary hybrid varieties, there are still some traditional varieties available. In the Northeast, the Penobscot and Abenaki still grow Long Pie (a.k.a. Indian or Golden Oblong) pumpkin.

This pumpkin looks like a fat zucchini with the texture of a pumpkin. It has a long storage life and usually doesn’t turn orange until after it is harvested. A disease-resistant variety suited for the Southeast is the Connecticut Field. This very vigorous Native American heirloom yields large, bright orange pumpkins. Mayo Blusher is a very sweet, pale gray pumpkin that blushes pink when ripe. Cushaw is a gourd-like squash that has been grown in the Southwest by the Pueblo Indians for storage containers since pre-Columbian times. Other varieties of squash also grow well in the Southwest depending on the amount of moisture available.

Cultivation and Planting Designs

Planting designs and cultivation practices vary according to climatic region. Garden styles were developed mainly out of practical considerations, such as moisture availability, climate, and the length of the growing season. The Wampanoag garden style works well east of the Mississippi. Hidatsa gardens were developed to thrive in the climate of the northern Plains, while the Zuni waffle garden was designed to conserve water in the arid Southwestern climate.

Figure 1: Circular Wampanoag Garden

Drawing by Mardi Dodson
Concept taken from Native American Gardening by Michael J. Caduto and Joseph Bruchac
Wampanoag Three Sisters Garden

It was the Wampanoag gardens that enabled the early settlers of Jamestown to survive and thrive in the New World. Squanto was a Wampanoag who “taught the newcomers to plant maize in little hills and fertilize each mound with an alewife, a species of fish” (5). With this efficient and intensive gardening style, each family could sustain their needs on about one acre of land. Many of the tribes of the Northeast, including the Iroquois, used the Wampanoag garden design.

Planted without plowing or tilling, the traditional Wampanoag garden includes corn, beans, squash, and sunflowers. The corn and beans are planted in mounds, with squash planted between the mounds. The sunflowers are planted along the north edge of the garden, so that they do not cast a shadow on the other crops (see Figure 1). When the sunflowers have bloomed and the squash and beans have flowered, the Wampanoag Three Sisters garden becomes a stunning cluster of red, yellow, and white flowers against a textured backdrop of shimmering greens.

First, the raised corn and bean mounds must be constructed. These small mounds are laid out in rows with 4 feet between the centers of the mounds (see Figure 1). Each mound is about 4 inches high, with a wide base (about 18 inches in diameter) that narrows to a flattened top (about 10 inches across). To conserve moisture, a depression with a lip may be formed at the top of each mound (6). The finished mounds have a remarkable resemblance to miniature moon craters.

When the mounds are ready, plant four corn seeds about 6 inches apart and 3 inches deep in the top of each mound. Once the corn has grown to a height of 4 inches or more, plant four beans seeds halfway down the slopes on the sides of each mound (see Figure 2). Allow the bean vines to entwine themselves around the cornstalks for support. The bean vines may be pruned if they get too aggressive (6).

Squash seedlings are planted at the same time as the beans. Construct rounded mounds 3 inches high and about 1 foot across at the base. The squash mounds are staggered between the mounds of corn and beans (see Figure 1). Traditionally, four seedlings are planted in the top of each mound. The seedlings are arranged to represent each of the four sacred directions (see Figure 3). Both winter and summer varieties are planted, including pumpkins, acorn squash, and summer crookneck squash (6).

Sunflower seeds are planted at the same time as the corn. The smaller-flowering common sunflower, *Helianthus annus*, is traditionally grown in a Wampanoag Three Sisters garden.
The sunflower mounds are located at the north edge of the garden (see Figure 1). The mounds are spaced about three feet apart from center, with three seeds planted (one seed per hole) atop each mound. The sunflowers seeds are traditionally harvested after the first frost (6).

**Hidatsa Gardens**

In the northern plains, the Hidatsa, Mandan, and Arikara peoples gardened along the floodplain of the Missouri River in what is now called North Dakota. Most of the tribes in this region used the Hidatsa garden design (see Figure 4). Hidatsa gardens are designed to have alternating, staggered rows of corn and beans, with sunflowers growing along the north edge of the garden. Squash is planted after every fourth row of corn and beans and around the east, south, and west edges of the garden (6).

Sunflowers are planted as soon as the threat of frost has passed. As in the Wampanoag garden, three sunflower seeds are planted in small mounds 3 feet apart along the north edge of the garden. The Hidatsa garden differs from the Wampanoag garden when it comes to seed arrangement—all three seeds are planted in one hole. Hidatsa varieties of sunflower produce black, red, white, and striped seeds (6).

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Plant squash indoors in peat pots or seed flats when the sunflowers are planted in the garden. Before planting in the garden, prepare the squash mounds (about 15 inches across at the base), with 4 feet between the centers of the mounds. The squash mounds are located along the east, west, and south edges of the garden in alignment with the rows of beans (see Figure 4). Squash seedlings are usually transplanted when they are about 4 inches tall and have put on their first set of true leaves (about two weeks after the corn is planted). To protect them from the heavy spring rains, four seedlings are planted on the sides of the mound in sets of two, 12 inches apart (see Figure 5) (6).

In the Hidatsa garden, there are usually four corn mounds per row of corn. Note that the rows of corn are in alignment but are staggered in comparison to the beans (see Figure 4). Hidatsa corn mounds are constructed in the same way as the Wampanoag corn and beans mound. The differences are that only corn is planted in these mounds and eight
seeds, instead of four, are planted in the top of each mound (see Figure 6). Growing corn together in bunches offers extra support and protection from wind and rain damage.

Hidatsa flint corn is planted in May in North Dakota when the leaves of the Gooseberry shrubs have emerged and fully formed. Corn is planted a week or two after the sunflowers have been planted. This flint corn is a semiarid variety with a growing season of about 70 days. It is advisable to research which corn variety works best for your zone and climatic conditions (7).

Beans are planted at the same time as corn. In a Hidatsa garden, beans are planted separately from the corn in their own mounds. The bean mounds are located between the rows of corn in a staggered, alternating pattern (see Figure 4). The mounds are rounded ovals, about 4 inches tall by 7 inches wide by 14 inches long. Traditionally, two people worked together to plant beans. The first person made six holes in the south-facing slope of the bean mound. This is done in one swift motion by thrusting both hands into the soil with the thumb and first two fingers extended to make two sets of holes spaced 6 inches apart (see Figure 7). The second person follows behind and plants one seed in each hole. A total of six seeds are planted in each bean mound (7).

**Zuni Waffle Garden**

The Zuni live in the Four Corners area of the Southwestern United States. This arid climate at altitudes over 7,000 feet makes gardening a special challenge. The Wampanoag and Hidatsa garden designs use raised mounds to keep the root systems from being waterlogged. In contrast, the focus of this garden is water conservation. The waffles are about 12 feet by 12 feet. Each individual square is indented and surrounded by a high rim. In each square, a single crop or combinations of crops may be planted (see Figure 8). This garden design will work anywhere in the country where dry summer conditions are experienced.

Traditionally, the crops are planted intensively with five to eight corn seeds in each hole to create clumps of corn similar to those in the Hidatsa garden. Corn seeds are planted 4-8 inches deep in light sandy soils and about 4 inches deep or less in heavier clay soil. Beans and squash have the same planting depths and spacing requirements as corn (8). The same number of beans (4-8 seeds) are planted around each clump of corn, one seed per hole. Only one or two squash plantings (4-8 seeds in each hole) are added to each waffle (see Figure 8) (3). As with the other two designs, sunflowers may also be planted along the
edges of the Zuni Waffle garden. Helianthus maximilianii, a small sunflower with flower heads about 3 inches wide, is most commonly grown in the Southwest (9).

**Summary**

Native American tribes of North America have made enormous contributions to the foods we eat today. The dynamic trio known as the Three Sisters not only thrive when they are planted together, they offer a well-balanced, nutritious meal. Over the centuries, many plant varieties and gardening styles were developed for each major climatic region. The Wampanoag (Northeast and South), Hidatsa (Plains), and Zuni waffle garden (Southwest) offer a range of gardening styles to accommodate most growing conditions found in North America.

Corn, beans, and squash have a unique symbiotic relationship in a Native American garden. Corn offers a structure for the beans to climb. The beans, in turn, help to replenish the soil with nutrients. And the large leaves of squash and pumpkin vines provide living mulch that conserves water and provides weed control. This ancient style of companion planting has played a key role in the survival of all people in North America. Grown together these crops are able to thrive and provide high-yield, high-quality crops with a minimal environmental impact.

**References**


The Electronic version of Companion Planting: Basic Concepts & Resources is located at <http://www.attra.org/attra-pub/complant.html>.
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